ENGLISH FOR STUDENTS
IN
APPLIED SCIENCES

The quality of the materials used in the manufacture of this book is governed by continued postwar shortages.

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APPLIED SCIENCES

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To

the memory of two inspiring teachers,

JOSEPH VILLIERS DENNEY

JOSEPH RUSSELL TAYLOR

Preface

This text for beginning college composition courses deals with English for students in colleges of applied sciences—with English, that is, as an instrument to aid professional progress and achievement. The point of view of the college as a whole, therefore, rather than that of the isolated English department has been the prime determining factor; and English has been further specifically integrated with the other subjects in the curriculums of applied science. On the other hand, the definite contribution of English composition to the students' general outlook, achievement, and personal development has not been disregarded, nor has the sound tradition of good English as a concomitant of clear thinking been disturbed. English has been put squarely before the students, with a minimum of academic terminology, and in its natural association with those achievements in which the applied scientist takes pride: clean copy, graphic materials, and standard presentation of results. Professional standards are illustrated by selections from letters, reports, articles, and books by expert writers in the fields of applied science. Practice topics within the range of the first-year students' usual background and stages of intellectual and professional development have been set forth in the problems for the various chapters; but the treatment demanded in the discussion and handling of them is typical of that required in any writing which is integrated with a profession that applies the biological and physical sciences.

Out of a knowledge of the writing demands made upon students in the colleges of agriculture, engineering, and pharmacy and of after-college writing requirements, all the aspects of English have been scrutinized, but only those which have a direct bearing upon proficiency in functional writing have been retained for extended development and study. Exposition with factual or expository description and narration is the fundamental form of discourse treated because it is the one most used in the report. All study of writing and practice are in preparation for report writing.

The material selected has been assembled to conserve the time and effort of busy students who, with an exacting first-year schedule of basic science courses, have, even under the most favorable circum-

stances, only limited time to devote to English. The plan of assembling is intended also to aid English teachers, who in the brief time at their disposal must do highly effective teaching in the classroom and deal constructively in the conference with matters of writing and points of view that concern individual students. The English teacher has and always will have the task of demonstrating how good English can improve the quality of professional work and give better enjoyment of leisure—the same functions that it can serve throughout the students' lives. To give students a start in the liberalizing possibilities of English, Appendix A, "Suggested Reading Lists for Students," has been included.

The presentation of this text presupposes no highly scientific background upon the part of the English teacher—just general knowledge which every well-informed person has, through his current reading on general science as it is presented in reliable books and periodicals for the lay reader. It suggests that the English teacher will do what every good conversationalist does—draw out the other person, find his interest, establish common ground, exchange ideas on subjects of mutual interest. Too often the student is asked to make all the adjustments and is entirely shut away from familiar ground.

The English teacher must, therefore, do his share in expertly guiding the students' thinking rather than forcing them, in their inexperience and without perspective, to select their subjects as well as guide themselves. Such guidance does not take away the initiative of students but permits them to go far enough in their thinking and practice to get more than a superficial understanding of English and, as time goes on, to strike out for themselves.

Since questions of point of view and insight into the place and use of English in the applied sciences are of major importance, no detailed discussion of the mechanics of writing has been included in this text. Students are referred to a handbook and other standard books of reference on English, as it is expected that a handbook will be used concurrently with this text. The text, therefore, makes clear to the students why they should know and use a handbook and a dictionary. The assumption is that both the teacher and the students will be wholeheartedly interested in what formal study of English can do toward professional success and individual personal progress of students in applied sciences.

The method of teaching set forth in this text is in line with the ideas of progressive education, for it offers practical writing problems which not only stress the general college objectives but also tend to make students aware of writing situations and writing demands in their everyday life. Every discussion, too, aims toward definite concrete pieces of writing in which they can achieve some measure of success.

The authors wish to express appreciation to John F. Moore and Robert E. Tuttle, Department of English, The Ohio State University, for helpful suggestions in the preparation of the manuscript; to the teachers of the first-year courses in English for students in the colleges of agriculture, engineering, and pharmacy, The Ohio State University, who by their teaching have demonstrated the workability of the methods presented in this text; to the students in these colleges who have cooperated; and, finally, to our friends and coworkers in the colleges from which our students come, who have stood behind us and have given us the opportunity to work out a difficult but genuinely stimulating problem in the teaching of English, and thus to do effective teaching.

THE AUTHORS.

COLUMBUS, OHIO,
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PART I

WRITING PRINCIPLES

Chapter One

English in Active Practice

TAKING THE INVENTORY

Every good businessman, before he starts upon a new business venture, as well as after a period of activity, takes an inventory of his stock to discover his assets and his liabilities. Every first-year student in the applied sciences, if he expects to get full returns for his time and effort in college English courses, will follow the practice of the businessman and take an inventory of his writing capital. Tests are often given at the beginning of these courses for just this purpose. Thus the student, as well as the English teacher, may discover the exact state of his proficiency in spelling, punctuation, grammar, and other indispensable points of the mechanics of writing. They are not ends in themselves but means to an end; expert use and adjustment make for accuracy, smoothness, and clearness. For these reasons, every farsighted student in beginning his college English courses will check his assets and liabilities. As soon as possible, he will cut down his liabilities and increase his assets.

APPRAISING MECHANICAL EQUIPMENT

As a guide to an extensive inventory of present capital in English, he should consider his writing from two angles: the mechanics of presentation, and the thoughts that are the reason for writing. Under the first, the mechanics of writing, he should check

1. The appearance of his written work when no specifications have been given by his instructor for the arrangement on the page. Good appearance—clean copy—makes a paper easy and inviting to read. It should be an effective setting for contents, not a substitute for contents. The student should see that papers submitted in chemistry and mathematics are as neatly arranged and as clean as the sheets he prepares for mechanical drawing. He should also be sure that written quizzes and final examinations are legible.

2. His accuracy in spelling. The most common reason for misspelling is carelessness.
3. His use and knowledge of grammar, the most conspicuous mark of the literate or illiterate person.
4. His use and knowledge of the methods and reasons for punctuation.
5. His use and knowledge of words. Approximately how many words does he think he has at his disposal? What words does he overwork?

These five items should reach their maximum and consistent effectiveness at the earliest possible moment, so that their correct application will be habitual. In Chapter Two, there is a discussion of handbooks and of dictionaries by means of which he can learn how to correct the weak points revealed by his inventory. He should undertake this work at once for himself and confer immediately with the instructor upon those points which he cannot work out by himself.

APPRAISING "NATURAL RESOURCES"

In considering the second angle, the thoughts that prompt writing, the student should think over

1. His interest in facts and ideas concerning his future professional work; in the basic sciences of his profession; in college as a whole; in people; in his home town or community; in his state, and in his country.
2. His attitude toward citizenship; his reading interests; his recreation; his hobbies; his experience with people and things.

In other words, does he have an interested and an interesting mind?

There are, it will be observed, two aspects to this inventory: one has to do with the form in which ideas and facts are conveyed; the other, with the facts and ideas themselves. Interest in facts and ideas, by far the more important, gives incentive to mastering form. Indeed, it is the only justification for any extended study and drill in form; for form is vital only as it interferes or aids in presenting ideas and facts.

SETTING UP STANDARDS

Clarity, vividness, emphasis in expressing ideas and facts are the final results of formal English study. Clearness of thought may be estimated by ability to handle sentences so that they have meaning;

by capacity for analysis in such courses as mathematics and descriptive geometry; by power in outlining. In Chapter Four are discussed the specifications for making a good outline and its uses. Vividness and emphasis can be checked by the effect practice writing and class recitations produce upon classmates and instructors. In addition, it is very desirable, and shows good sense, as well, to be proficient in the mechanics of writing at the beginning of the college English courses; in fact, the student should demand proficiency of himself so that he can put all possible effort and every spare moment in his formal English courses on the problem of discovering and analyzing his thoughts and expressing them with clearness, precision, and force. He cannot expect English to furnish all his ideas; English should only stimulate, reinforce, and enrich his own. He should bring to English something to say, an interest in people and in his profession, and an ambition to find out how he can best communicate his thoughts, *i.e.*, how he can put into language his professional facts and his social ideas so that people will listen, understand, reflect, and act upon them. English, therefore, becomes a joint project: the student works on presenting subject matter of interest and value to him; the instructor advises and helps the student in editing his writing.

USING ONE'S OWN "NATURAL RESOURCES"

The more the student can offer in the way of subject matter of individual import, the more he will gain from his college English courses. Indeed, he should demand that these courses give him a chance to express and improve his own ideas. On the other hand, he can rightfully be expected to be alert to the far-reaching possibilities of English study, and aware of the world in which he lives. Thus he can understand, in a comprehensive way at least, the significant tendencies and the outstanding events in his time, both within and without science. Indeed, he needs his information in the pursuit of his profession, which is alive only in proportion as it is related to the times. Correctness of form, clearness of thought, and vividness of explanation of informative and scientific facts, and individual accurate interpretation of them to a particular reader or group of readers are necessary to demonstrate how his profession is applied to the needs and uses of people in his own generation.

EVALUATING ENGLISH AS A TOOL IN THE APPLIED SCIENCES

The interrelation of effective English and the writing in concurrent and future professional courses cannot be overemphasized. The formal training in writing, applied in all courses, will increase the force of the work and the results of the professional subjects. In fact, English is a tool for making scientific facts clear and vivid, just as are mathematical symbols, chemical formulas, and graphical representations. Since English is a professional fundamental, it is advisable to learn just where English will be helpful in later technical courses, and how these demands and practice will prepare for active work in the profession after graduation.

WRITING DEMANDS IN APPLIED SCIENCE CURRICULUMS

What are the usual writing demands in the curriculums for students in the applied sciences? There are two main kinds: reports which are the culmination of extended laboratory work, and often research besides; written quizzes, midterm and final examinations, in which are summarized the results of study inside and outside the classroom. A standard procedure for presenting the facts and the inferences from these facts, and the opportunity for preliminary planning and for revision are distinguishing characteristics of the report. Selection, analysis, and clear, accurate, and concise assembly of relevant information almost on the spur of the moment, with little chance for revision, are the outstanding features of the examination, which must necessarily be impromptu writing. These two forms, the planned and revised report and the impromptu selecting, organizing, and discussing of the salient facts of a presumably familiar subject, are typical of the writing demands in active professional practice. Here are required extended articles and reports which may be revised for phrasing, as well as checked for the accuracy of the scientific facts involved, and the letters and brief articles which can have only slight revision. Those required in the performance of the daily routine obviously cannot have the finish of the report which is given time. Yet they must be in acceptable English, *i.e.*, besides being accurate factually, they must contain no glaring errors in spelling or grammar, and no ambiguous statements. The student should expect,

therefore, to have sufficient power to do satisfactory writing under any circumstances.

CHECKING PERFORMANCE UNDER PRESSURE

For this reason, at the end of each unit of first-year college English, he should ask himself whether papers written in the English class hour have quality, and whether he has to apologize for the mechanics, organization, and phrasing he has used in examinations in other courses. Class papers in any course, written under pressure, demonstrate significantly the constant quality of a student's writing. In fact, the final examination often gives a more accurate indication of how his English will aid or detract from his achievement in his profession than do the long papers he may have written outside of class during a course. The class theme and the final examination reveal the student's real grasp of English.

REPORTS IN COLLEGE AND IN ACTIVE PRACTICE

The long papers, generally given the name of reports, which students in the applied sciences are required to write as a part of the procedure in technical courses, range from 1500 to 3500 words. They present discussion of and inferences drawn from experiences in the college laboratory, in the field, in the clinic, in industrial and commercial plants; from observations and inspections of applications of science; and from library research. In their more advanced forms, they are usually a combination of all the various sources. In active practice, reports are an inseparable part of any professional activity. So important are they that their quality is considered to be a measure of a man's professional ability. Since the report belongs to the job, the college student will want a thorough understanding of the basic principles of report writing.

KINDS OF REPORTS

The reports of experience relate and record personal participation in an activity under actual working conditions. The laboratory reports describe apparatus and tell what work the apparatus performs; those on observation and inspection picture the equipment and working conditions of plants. These demand not only a photographic account in words of the actual material and equipment involved but also, as

professional knowledge increases, analysis and interpretation of the basic scientific facts. Through the library investigation for the simple research report, the student may discover how extensively and how long a particular scientific problem has been engaging the thoughts of men, and what are the present-day conclusions concerning it. Books preserve the facts and conclusions that others have worked out through experimentation, observation, and reflection.

The after-college needs for English are largely a continuation of those of the college years: the professional reports continue, for the most part, to require research in the library as well as in the laboratory, to be accounts of experiences, observations, and inspections. For details of the particular and extended writing demands, the interested student should consult the men directing his professional courses. In addition, some of the professional societies have made studies of these demands. It is safe to assume that some form of report writing will be required—though in varying degrees, of course—in every profession that is based upon the applied sciences.

FINAL SPECIFICATIONS FOR PROFESSIONAL WRITING

Good professional writing grows out of facts and inferences on scientific material. It must have the following qualities:

1. Correctness of mechanical form, such as correct spelling.
2. Clear expression of thought, so that there can be no doubt as to the intended meaning.
3. Vivid presentation that will interest a particular person or group of persons. Technical writing is not "broadcast" or "to-whom-it-may-concern" writing. It is planned for a definite purpose; it is addressed to individuals with special interest and needs, or it is so gauged that it will appeal to general readers who want and need a simplified, scientifically accurate presentation of various aspects of the applied sciences.

THE ROAD AHEAD

Since English is an element of all professional activity, men considering every aspect of their professional training will be quick to recognize its significance. At the outset of their college training, they will attack the study of English with open and interested minds. Skill in English will yield constantly higher interest on the original investment. Every ambitious student, therefore, will welcome every opportunity to practice writing, and will find time to extend his

knowledge. In the detailed discussion in the succeeding chapters of this text, the various units involved in written presentation generally, as well as those that belong peculiarly to certain particular professions based upon the applied sciences, will be explained. Opportunities for trying out one's present proficiency, and for practice to gain, maintain, and perfect writing skill, will be suggested. In English there is no limit to the amount of self-training an ambitious student can carry on for himself, in order to get command of the basic writing procedure. After he has completed his formal English training, he must expect to proceed mostly under his own power. How much power he will have at the end of his English courses depends largely upon his attitude and his willingness to practice writing in season and out of season. Though training in special forms of writing is often offered in later college years, the basic principles and the fundamental forms are those with which the student becomes familiar in the first-year English courses. In fact, the special forms are only adaptations and extensions of the principles and forms of the first-year writing courses. If no particular specifications are available, the student may expect to meet requirements if he will put into practice the knowledge and training in writing of his first year, especially if he has considered all succeeding writing demands in his professional courses as opportunities to maintain the acceptable standard that he developed in his first-year formal English courses.

Problems

1. Take an inventory of the present status of your competency for writing by checking against the items listed under the mechanics of presentation, pages 2 and 3. Set up the material in some such fashion as this:

a. Appearance of sheet: Satisfactory.
b. Spelling: Fairly accurate, though I am never sure of such words as *planning*, *dining*.
c. Grammar: Accurate except sometimes I misuse *who* and *whom*.
d. Punctuation: Uncertain about use of comma in a series.
e. Words: Overuse of *quite*.

Under each heading, be definite and where necessary go into some detail in explaining your practice in relation to these various items.

2. Appraise your "natural resources" for writing by the following exercises:

a. List five topics connected with a particular branch of an applied science about which you know, or in which you have a keen interest, such as radio, aviation, automotive engineering.

b. List five topics related to sports that you know either as a participant or as a spectator, such as fishing, hunting, baseball.

c. List five general topics about which you are informed, or would like to know, such as some aspect of travel, reading, or a hobby.

d. List three topics dealing with interesting features, activities, or industries in your home town or community.

e. Enumerate the facts that you have gathered about your future profession; about the courses that make up your particular curriculum.

f. Discuss your attitude toward participation in such general college activities as athletic, literary, social, musical, dramatic.

g. Name ways in which students might participate in general community activities.

h. Discuss your methods of keeping up with current events.

i. Discuss your sources of information on current happenings in all fields of modern science.

j. Note topics of conversation of some of the interesting people you have met.

k. Note topics of conversation of students.

3. Indicate for all the topics listed above those upon which you are able, without further preparation, to write 500 words; those upon which you should check, by reading, observation, or interview, before you would be competent to write 1000 words. Be sure to narrow each topic so that it can be adequately handled in either 500 or 1000 words.

4. Look over a short piece of writing that you have written for another college course for the five items listed under the mechanics of writing on pages 3 and 4. What are the most glaring errors? Rewrite the paper so that these faults will be eliminated; then, in a brief discussion of 75 to 100 words, compare and contrast the two, and justify the retention of certain parts of the original paper, as well as the changes that you feel are necessary.

Chapter Two

Writing Supplies and Writing Standards

DESK WORK

Writing is desk work. Like every good workman, the student collects his supplies and arranges them conveniently upon his desk so that he may work with speed and accuracy. Records, letters, reports, in some cases articles for publication, make up the writing part of professional practice whether in college or in after-college work. Indeed, because of standard specifications, the standard office appliances so necessary in modern offices to carry on a volume of business have been invented. Regardless of the particular form of handling, functional writing requires paper, cards, and envelopes, fountain pen and ink, a desk dictionary, and a handbook on English. Their use makes for clean copy and good English. Even though the student has to get along with minimum equipment, he can nevertheless learn and use standard practice, even while in college. In fact, the indispensable equipment will last until he is at least five years out of college. The student, therefore, should consider his supplies for writing as essential as his instruments for drawing.

DESK MATERIALS

Ideas are recorded, and written material is made easily accessible through some kind of standardized setup. Poetry has been put down on the back of envelopes, but not read by many persons in that format. For the records to be filed, the letters and reports to be read, and the articles to be published, it is customary in the best practice to use paper and cards of certain size, quality, and color.

Cards.—To record ideas that will later be worked up into extended discussion, and lists of references that will make up the bibliography for a research discussion, cards 3 by 5, 4 by 6, or 5 by 8

inches are needed. Small envelopes, special extra-heavy paper containers, or wooden boxes will carry them. They fit in filing cases or cardboard transfer boxes of the appropriate size, which is often the same as that of the drawers in a library card-catalogue cabinet. Cards are usually white, ruled on one side and blank on the other. Since the practice is to write on one side only, they are suited for typing or handwriting.

EXAMPLE: BOOK REFERENCE

CLARK, THOMAS ARKLE

When You Write a Letter

Benjamin H. Sanborn & Company, Chicago, 1922.

165 pp.

EXAMPLE: WORKING OUTLINE

Outline for Term Paper

Uses of the Soybean

I. Properties of the bean

II. Uses of the dried bean
  A. Stock feed
  B. Human food

III. Uses of the green bean

IV. Uses of soybean oil
  A. Human food
  B. Industrial uses

V. Uses of soybean meal
  A. Human food
  B. Stock feed
  C. Industrial uses

In the preceding examples of cards, some of the functions and the arrangement of material are indicated so that the student may visualize practical uses for this part of his desk equipment.

Cards 4 by 6 or 5 by 8 inches will take care of topical notes, which follow the rule of one point only on each card, with a topic as its heading. A working outline for the assembly of such notes is also possible on the same size of card. It is easy to get envelopes and special containers, especially for the 5- by 8-inch size. Color and ruling resemble those of the 3- by 5-inch cards. Because of the inconvenience resulting when there is much arrangement and reference work to be done, it is poor economy to use any makeshift cards.

EXAMPLE: TOPICAL NOTE

I.

Properties of the soybean

30 to 46 per cent protein
20 to 30 per cent carbohydrates
12 to 18 per cent fat
11 to 20 per cent oil

Protein and oil contents vary greatly with varieties,
Biloxi variety having greatest amount of each.

U.S.D.A. Farmers' Bulletin, No. 973, pp. 13–17, 20.

More extended discussion and further examples of the uses of cards will be found in the chapter on the simple research paper (Chapter Thirteen).

Paper.—Unruled paper 8½ by 11 inches is standard for letters, reports, articles, and most business and professional copy except certain legal documents. Some of the paper may be punched for notebooks and bound reports; and some kept intact for letters. The best color for all practical uses is white. Ruled paper, provided the lines are not less than ⅜ inch apart, may be suitable for student problems and reports but never for letters. Containers include business envelopes for folded letters, large Manila envelopes for flat copy, and folders for filing, in addition to standard binders or covers for reports.

The standard-size paper is used for a wide variety of forms, of which list bibliographies, letters, and ordinary continuous copy are typical. The student has only to check on the numerous pieces of written work required constantly in his own curriculum to find examples.

The final copy is to be handled either by readers or printers. Hence, the quality of the paper should be good, firm and absorbent enough to take the ink impression from pen or typewriter. For typing, a clean ribbon may cost a little money; cleaning type requires only a small amount of labor with a pin and a brush. Carbon copies on inexpensive second or onionskin paper should not be submitted, though they should be kept in one's own files, especially in the case of the letters and reports. As the writer's permanent record, they are his factors of safety, should his originals be challenged.

Ink.—The best ink is dark blue or black. Dark script against white paper space imitates print. Colored inks, like colored paper, are desirable only for art work or special effects. A two-color typewriter ribbon, however, helps to indicate what the printer displays by means of various devices of type, especially different degrees of subordination in headings. The quality of the ribbon and of fountain-pen ink can be of the best, with hardly noticeable difference in expense.

Tools.—The tools of desk work are pens, pencils, and if possible a typewriter, though typing is not always necessary. Papers in script may be just as attractive as those that are typewritten. They require only careful attention to setup, spaces, margins, underscoring, headings, and the like, and more sheets of paper, to get the same effect as the typewritten page. Furthermore, careful, legible handwriting is always acceptable in English courses. In many types of professional work it is demanded. While a pencil is a poor medium for recording ideas for written work, a medium soft one may come in handy for blocking out graphs, tables, and illustrative matter generally. To the engineer the drawing board goes along with the desk as an inseparable piece of equipment. His drawing pencils and, even better, his drawing pens and special ink are ready when special problems of lettering come up.

Miscellaneous equipment, such as blotters, erasers, clips, and rubber bands, costing little, complete the equipment necessary for

turning out paper work which is standard from a mechanical point of view.

CLEAN COPY

The clean-copy habit may be greatly furthered by buying the best of desk materials and tools that one can afford, and by constantly trying to get the best use out of them through proper care and attention, such as storing blank cards and paper in suitable containers and cleaning pens or typewriter regularly. Then comes the problem of putting facts and ideas on paper. The most effective solution of this problem is that which results in the highest degree of visibility, accessibility, and symmetry.

Visibility or legibility is first in demand. The manuscript should be free from strain on the eyes and from distractions due to cross-outs and strike-overs. Neat and careful erasures will not be condemned. Yet the script itself does not tell the whole story of visibility. The finished page of the manuscript should be as well set up as one for drawing; and the typescript, as one for printing. A page without margins is unreasonably hard to read. The white space which "frames" the text is designed not primarily for ornament but for aid to reading and relief to the eyes. The same is true of spacing between lines. Though single space is customary in letters, especially when it contributes to the general balance of the page, double space is preferred in reports and articles. In handwriting, if the letters are large enough to tangle above and below, as they often are, even on paper with rules $\frac{3}{8}$ inch apart, alternate lines must be omitted.

Standard margins, let us remind ourselves, are not two but four in number: top, and inside (left), plus outside (right), and bottom. The width varies with special needs: final copy may carry an inch all around; and where binding or marginal corrections are to be expected, the inside, or left-hand, clearance should be at least $1\frac{1}{2}$ inches. Special directions for first-draft writing are given at the end of Chapter Eight.

Accessibility is another fundamental need of efficient paper work. It is one thing to file, and another to find what one wants. Cards, notes, and letters are usually filed alphabetically, with some allowance for topical groupings. Labeling goes along with filing. Index cards serve as guides in 3- by 5-inch, 4- by 6-inch, or 5- by 8-inch

boxes. These containers and others, such as folders and binders, need stickers or written labels on the outside. It takes only a little care to tag the contents of each container with a title, a number, and the name, with other identification of the writer and the receiver in case the papers have passed or will pass into other hands.

Accessibility regulates the placing of items on cards or pages, as well as filing and mailing methods. The reader has the right to find information at the expected point. The value of standard positions, briefly illustrated in the examples given in this chapter, will be explained more fully later in connection with letters and reports, with their many formal features which in the long run prove to be extremely practical. Special directions for procedure that will make for the greatest visibility and accessibility in the report will be given in the discussions of the format of a report. But regardless of what type of writing is involved, it should always meet these two specifications if it is to "invite" reading. Reference to any well-planned magazine advertisement or sales pamphlet will immediately demonstrate that these two specifications have been recognized.

Symmetry is also a requirement of clean copy. It implies an artistic quality which will be appreciated by any student in engineering drawing. Well-balanced pages are not only easy to read; they are attractive in themselves. Attractive copy does not call for overemphasis on color, extreme cover design, or pasted-in pictures that suggest the wallpaper in the nursery. The art of lettering and the art of printer's composition are both practical, like many other arts. In scientific writing there are many special parts, to be illustrated in later chapters, in which symmetry is taken for granted because it not only pleases the eye but definitely aids accessibility and visibility.

DESK BOOKS

The problem of correct English (one is tempted to say "clean English") is somewhat different from that of clean copy, which is a job mainly for the hand and the eye. The laboratory or field worker, accustomed to handling things with care according to standard methods, soon makes headway in paper work as to visibility, accessibility, and symmetry. His labors with standard English take more time and thinking. To reach the highest effectiveness with the least effort, he must follow definite rules which summarize standard

English practice. He must obviously first learn the reason for them. Even before that, he must learn where to find them.

The wise student has the same attitude toward the English handbook and the dictionary as the man in active practice has toward his scientific encyclopedias and handbooks which give him in concise workable form the facts, formulas, and tables for which he has constant use. Indeed, only by having a desk dictionary and an English handbook available for reference and by using them constantly can any practical writer expect to write papers that will reflect credit on himself, his organization, and his profession. It is an indication of strength to use them. Every careful writer keeps these two books at his elbow.

Dictionary.—The dictionary is needed to settle questions of word uses and word forms (spelling and pronunciation). One of the most vital points is the good standing of an expression, for the language used must be not only clear to the reader, but also not discreditable to the writer.

First of all, the writer wants to know whether he is using a word in the right sense. The dictionary gives *meanings* by definition and example. The logical part of language is well cared for by definition, but there is much nonlogical matter in English and other tongues which cannot be defined; it can only be illustrated. For ordinary needs the dictionary will give enough information as to right sense. For finer discriminations, especially in the connotation or suggestive coloring of language, a book of synonyms may be consulted. The synonyms in any one of the good desk dictionaries will also be found useful.

Synonyms provide fine variation in meanings and in suggestion. Even the difference in length or sound may have an effect. For example, the term *sequence* implies more logical connection than does *series*. In mathematics these terms are technical and therefore not synonymous, since technical terms have, or should have, no equivalents; but in general discussion, pairs like *series* and *sequence*, *work* and *energy*, *culture* and *cultivation*, *percolate* and *trickle*, and many others make it possible to say a thing on varied levels of exactness and vividness. In addition to synonyms, the accurate use of common, widely circulated words needs checking by reference to the dictionary. The difference between *affect* and *effect*, *accept* and *except*, *corporation* and *cooperation*, though partly a problem of spelling, goes deeper than

the form into the basic function or use of the word, with that quality of precision which is perhaps the first requisite of scientific writing.

After the writer has checked whether he is using the word in the right sense, his next concern is whether he can fit words. How do they work in combination or what is the proper *context* phrasing?

In such examples as the following, the desk dictionary will give a clue to the use of prepositions and other connectives in combination:

used in metallurgy merely *as* a source of heat
changing the receiver *at* intervals
affected *by* temperature and pressure
conditions which prevail *during* combustion
water that is wholesome *for* drinking
prevent the wheels *from* slipping
placed *in* a small porcelain dish
passes *into* solution
process *of* oxidation
experiment difficult *to* carry out
under the action of gravity

The dictionary includes words of all kinds. If their standing is good, nothing is said about it. If the expressions are slangy, dialectal, or colloquial (that is, on too low a colloquial level for formal writing), usually some warning is given. For example, *juice* for *electricity* is labeled as slang; *reckon* for *suppose* is labeled as dialect; *phone* for *telephone* and *plumb* for *completely* are labeled as colloquial. Obsolete and archaic words are also designated; but such old-fashioned words are not likely to be used by student writers.

It is not within the right of a dictionary to establish the good or bad standing of any word. That authority rests with usage alone. The actual usage of the best writers is the determining factor; and it is a faithful record of such usage which the dictionary aims to present. Thus, the dictionary is a reliable guide for all practical purposes.

Spelling presents problems which at some time send every writer to the dictionary. English spelling is very irregular, for reasons that interest the specialist in language but provide little help to the practical writer. Though there are some rules which govern large groups of words, every careful writer, when in doubt, looks up the spelling of a particular word in the dictionary.

Pronunciation is a main item in the modern wordbook. Those who have difficulty in learning through the dictionary how a word is pronounced should begin by studying the key words printed at top or bottom of the vocabulary pages. By comparing the respelled forms which follow the original words, in parentheses, one can determine what the various letters and diacritical marks stand for.

The amount of *grammatical information* given in small space in the dictionary is astonishing. Indeed, so much is presented in limited space that probably it will not be thoroughly understood without a preliminary course in English.

The dictionary also contains much *miscellaneous information*, some of which lies in the borderland between the wordbook and the fact book, or encyclopedia; but most of it is directly related to the use of the language in writing or speaking. These details include grammar, punctuation, capitalization, italics, compound words, proofreading, preparation of copy, technical signs and symbols, proper names of both persons and places, foreign phrases, and directions for interpreting the vocabulary entries for pronunciation and varying grammatical forms.

At the beginning, probably, the writer has used the dictionary for looking up words in a hurry. He has seldom taken time to make exploration of it to know what there is and where it is to be found. The dictionary can be expected, however, to give the extent and location of the main items of information, in the fields of grammar, spelling, pronunciation, usage, derivation, meanings, and synonyms of the original word, and all its grammatically inflected forms. Only by knowing what the book contains, and where any particular point is to be found, can a writer realize what a timesaver a dictionary is. The student writer will find much of value by pausing over the words with which he has most trouble, long enough to find out what the dictionary can give him about them. Take such a word as *choose*, an irregular verb, which causes trouble in spelling, pronunciation, and grammar. Careful study of this word in a dictionary will settle the questions concerning it for all time. Then, there is that most fascinating study of the history and developed uses of words, which give them romance and range.

Handbook.—The English handbook deals with style or effective phrasing, grammar, mechanics or "clean copy," usage or correct language, and supplements the dictionary on questions of usage,

effective expression, and mechanics. For *revision*, or what is better, "prevision," or advance correction of most of the common faults in sentence structure, punctuation, grammar, word uses, and spelling, it is a sufficient guide. It serves the same purpose in English as technical handbooks in the applied sciences, or as a book of directions included in the toolbox of any piece of equipment.

In some handbooks of writing the rules are perhaps overstrict. Modern literary opinion is tending away from the "purism," or excessive language restriction, of previous generations. Yet the actual practice of professional writers of high rank tends to agree with the conservative attitude of the manuals. Great men of science show their originality in discoveries and inventions rather than in eccentric experiments with style. It is the careless or incompetent writer who disregards the standard usage of the best professional journals.

The handbook covers a wide range of topics, for the simple reason that good English involves so many problems. Separate rules to meet these problems run from 100 to 500 in number. Effective phrasing is included, as well as grammar; mechanics and clean copy, as well as usage and correct wording. The help of the dictionary, which deals with some hundred thousand of words individually, is backed up by general directions for determining exactness and good standing of whole groups of words, and for spelling certain classes which follow definite tendencies. In short, the handbook is a handy working grammar, if grammar is understood as the picture of the main habits of the language rather than its countless separate actions. For example, the precise and standard use of *leave* and *let* ("leave it alone," "let it go"), and the rule for spelling *ing* forms, like *dining* (from *dine*) and *hitting* (from *hit*), may be learned more economically from the handbook than from the dictionary.

Errors in basic *sentence construction*, such as the use of a sentence fragment, noted in practically every handbook as the period fault, are usually an indication of lack of complete knowledge of the grammar involved. It is difficult, if not impossible, to get exactness in language without some grammatical study and analysis. At the outset of his formal study of college English, the student on his own initiative should become acquainted with the more common terms of grammar. These he can find listed in his handbook. If he will spend a few hours of concentrated study on them, then check his own practice in writing, and follow up, in the handbook, the references noted

on his papers by his English instructor, he can correct his basic faults in writing. By this frequent correction of mistakes and by considerable practice in careful writing, the student can reduce his major errors to a minimum. When he feels sure of avoiding these, he may give attention and energy to the minor ones.

Punctuation is more than a mere formality. Period, semicolon, and comma are precision symbols almost as exact in their way as sin x or CO, and not interchangeable. The basis underlying precise punctuation is largely grammatical. Sentence structure is the foundation.

In matters of form, probably the great trouble arises in *spelling*. If the student writer really means business, he will overcome most of his misspellings. In a handbook, he will find two aids to accurate spelling: a group of rules relating to the most common causes of spelling errors, and a list of those words of which the spelling cannot be prescribed by rule. A little concentrated, but not lengthy, attention to these two aids will appreciably reduce misspelling.

Every student who wishes to make economical use of his time for writing will take advantage of any directions he can get in his formal English courses for efficient use of the handbook. Thus, he can overcome his errors and strengthen his good points. The handbook is his workbook; the dictionary, his reference book.

GOOD ENGLISH

Standard usage is perhaps the first requisite of good English which the dictionary and the handbook help the writer to master. This requirement is especially strict in scientific writing. Expressions like "leave it lay" and "dinning-room" bring English down to a substandard, illiterate level which is entirely out of place in professional practice. One of the troublesome things about standard usage is that the test is always a mistake, or a striking variation from the accepted form. Thus, one can never be sure of his language without considerable study of it, unless he has had unusual opportunity to read the best writers or converse with the best speakers.

As a matter of fact, standard usage is a prerequisite for professional writing. The same is true of *precision*, a quality which is carried over from the laboratory and from mathematics. Just as the scientific worker handles acids, measuring instruments, exponents, and curves with special care to avoid ruinous errors, so the scientific writer

handles outlines, paragraphs, sentences, and words, technical and nontechnical, with greater precision than do those who are interested only in crude results.

Precision in the use of technical terms, symbols, and formulas lies partly beyond the scope of dictionary and handbook. The student will have to consult technical books and instructors for the accepted standards. But there is a large range of language which is precise without being technical. The logical relationships of scientific thinking demand exact, complete, and relevant statements. The sentences to be found in the better class of scientific journals are especially interesting in their quality of precision. They seem to be inspired by the aim of telling the truth, the whole truth, and nothing but the truth.

Clearness and *interest* are also essentials of good English in which the dictionary and the handbook are of aid. The use of the right word, especially the familiar word, skillful sentence structure, and good paragraphing are among the prime aids to clearness. Variety, vividness, and suggestiveness are the main interest goals to be reached. Clearness and interest present many advanced problems, to be studied later on. Generally speaking, it is best to solve the elementary problems first, but since all writing is progressive, we may look to the future and jot down effective and expressive ways of putting things while we are laboring with preliminary notes, outlines, and first drafts.

PREVISION

In fact, the policy recommended in this book is one of prevision, to save revision. The value of such advance correction may be seen by a glance through the chapter on The Final Copy. Revision, even when reduced to its lowest terms, means checking on hundreds of details.

Just as an automobile manufacturer checks each car before it is sent to the salesroom, so every writer applies some last test to his final copy before it is released to the reader. The careful writer perhaps does more revising than the careless one; yet the drudgery of making corrections will fall more heavily on the unsystematic worker. The systematic one, by consistently using good language and good form, can build up his writing to an acceptable standard.

He may learn the good English habit: first, by checking every mistake, learning the rules, and avoiding all similar mistakes in his future writing, regardless of its extent; second, by studying the handbook systematically. A good plan is to proceed from "favorite faults" to the entire section in which they belong. Another is to go through the whole book to see what it is all about before settling down to particular rules. A third is to schedule regular periods for practice writing and all other writing which does not demand "inspiration." This routine is especially suitable because in college and in active practice most professional writing is by assignment. The first attempts at this procedure may require heroic concentration and effort, but persistent practice will make the writing process really an integral part of applied science activities.

Problems

1. *Copy Work.*—Write out by hand or typewriter one full page (standard 8½- by 11-inch paper) of symmetrical, legible, and letter-perfect copy, taken from a scientific book or article. If the matter is all continuous paragraphs, a second page should be done for broken text, with tables, formulas, or cuts, requiring special care in spacing. Illustrations may be reproduced by tracing, provided they are not too large. All rule lines in tables should be included. Type variations may be indicated by regular devices, such as underlining with one straight line for italics, with one wavy line for boldface, with three straight lines for large capitals. In the case of small capitals, the letters may be typed or drawn by hand, or underlined with two straight lines. All marks of punctuation must be included, with proper spacing. The exercise should be repeated until the copy can be made without a single mistake. The exact source of the matter copied is to be indicated at the top of the page.

2. *Bibliography.*—Write a simple bibliography card (3 by 5) for this textbook, your dictionary, or your English handbook, from the model given in this chapter. Follow the model closely for arrangement, form, spacing, punctuation, and contents. More challenging models will be found in the chapter on The Simple Research Report.

3. *Containers and Labels.*—Secure containers of standard size for cards (3 by 5; 4 by 6; 5 by 8) and paper (8½ by 11). Cardboard boxes, stout Manila envelopes of special make, and strong paper folders are needed. Print the labels, such as *Bibliography*, *Notes*, *Copy*, on stickers to be pasted on the outside.

4. *Spelling.*—List the words you most frequently misspell, on 3- by 5-inch cards. At the top of a card write the correct form of the word, first in printed

letters, then in ordinary handwriting. (It is recommended that the printed forms be made very large, on the unruled side of a card.) The next entry should be the handbook rule covering the particular case. This may be printed merely as a number at the upper right-hand corner of the card, in convenient position for later classification. At the bottom write: *Misspelled*, followed by the incorrect form, in small but legible letters. Arrange the cards by handbook rule.

5. *Good English.*—Record your most common mistakes in sentence structure, grammar, diction, and punctuation on cards of proper size (4 by 6 or 5 by 8). At the top write a brief label such as *period*, *participle*, *conjunction*, and at the right-hand upper corner print the number of the corresponding handbook rule. Beginning at the second line, write or print a corrected form, preferably a complete sentence, or a clear example of good English related to the problem. It is recommended that this correct example be given in large letters or with extra spacing. The next entry will be a brief statement of the handbook rule. At the bottom write: *Bad English*, followed by the incorrect form as it has been noticed by the instructor or yourself in your own writing. Classify these cards by topic and handbook rule.

6. *Mechanics.*—Follow the procedure given in Exercise 5 on *Good English*, using smaller cards, if possible. Confine this group to mechanical errors in the use of small items, such as the apostrophe, the hyphen, italics. Do not include matters of punctuation which relate to sentence construction. As in the previous exercises, it is recommended that the correct form be written or printed *large*.

7. *Words.*—Copy exactly the dictionary definitions for the following words: *already*, *anxious*, *continuous*, *detract*, *effect*, *except*, *factor*, *incident*, *observation*, *principle*. Use an 8½- by 11-inch page for each word. Write out a sentence using the word in question correctly in at least one of its meanings. Additional information may be found in the handbook list of words often confused or misused. The following phrases may be helpful as suggestions:

already crystallized
anxious about the infection
continuous curve
faulty lubrication detracts from the efficiency of the machine
the erosion control was effected by government agencies
pressure is an important factor affecting the density of a gas
changing tires was a minor incident of the trip
precise observation
principle of moments

The illustrative sentences in this exercise may be of your own composition, or drawn from scientific books and articles.

8. *Original Copy.*—This exercise is similar to 1, *Copy Work*, except that the matter is original. It may be a page of a required long paper, a short piece of assigned writing, an abstract or summary of reading, or a letter of transmittal (see Chapter Five). If one page is all continuous paragraphs, another page should be made for broken matter. The original copy is to be tested for good form and good English. Margins and spacings should be symmetrical. The page should be rewritten, if necessary, until it is letter-perfect. It should look like a page in a finished long report. The object is to establish habits of accuracy by *prevision*, and save time and trouble on later revision.

Chapter Three

Collecting and Recording Facts

IMPORTANCE OF FUNCTIONAL WRITING

In the practice of any professional activity, functional writing is indispensable, for the methods and the results must be discussed before work can be called complete. This factual writing deals with actual scientific facts and their application; it is requisite to any one of the professions applying the sciences. Another distinction is that it is seldom initiated for its own sake. It is generally an assignment, as has already been pointed out, which must be done in the course of the work. It has an advantage over other types of writing in that the subject matter is at hand, and there is the fullness of scientific knowledge and professional practice upon which to draw.

SOURCES OF PROFESSIONAL REPORT MATERIAL

The facts for all professional writing as well as for practice writing come from four sources:

1. *Experience*, *i.e.*, actual participation in the activity or the work.
2. Alert *observation*, *i.e.*, looking at all things with a "camera eye."
3. When experience and observation are combined for seeing and evaluating, the resulting method is *inspection*. That is, experience gives knowledge of the fundamental process or procedure. With this knowledge as the measuring instrument, the spectator sees and understands what is beneath the obvious and the visible. These three sources—experience, observation, and inspection—have increasing value as the professional man becomes more and more mature and expert. They depend upon individual activity, thought, and skill.
4. Out of the richness of experience, the accuracy of observation, and the thoroughness of inspection are experts developed and books written. The fourth source of information is *books*. By reading with understanding,

the student makes himself free in the world of books, gains the information that the experts have thus made available, and has models and patterns—not molds—for the expression of his own ideas; for the ideas in books must be regarded as raw material, just as is the tangible material that goes into the making of any commercial product or structure. Reading, therefore, should be for information and the stimulation of thought. The reader then tries his hand at the phrasing of the resultant ideas. He should be neither a servile imitator nor a plagiarist who palms off the efforts of others as his own.

ALERT THINKING A PROFESSIONAL REQUIREMENT

Because the writing of the applied scientist is an integral part of active professional practice, he must understand thoroughly the routine of his daily work, appreciate the need for observation and examination of similar and related activities, recognize what reading books and hearing lectures on scientific subjects can add to his fund of professional and general knowledge. Then, when the demand arises, he can give a faithful account of what he has done, make a clear photograph in words of what he has seen and examined, and analyze and make accurate deductions in the light of his experience, reading, and study.

NOTE TAKING—RECORDING THE DATA

The information from various sources, of course, must be assembled and stored in some tangible form. Then, the material is available when the occasion demands that the individual express himself. Sometimes this material is accumulated over a period of many years, even a lifetime. Scientists call the procedure of assembling and storing information *recording* data; *i.e.*, they preserve in writing facts, propositions, qualities, or conditions, granted or known. From these, other facts, propositions, qualities, and conditions are to be deduced. Note the two reasons for recording data: *preserving* facts, propositions, etc., *deducing*, or *deriving* other facts, propositions, etc. All note taking has these two aims, though usually the two parts are not so sharply separated. Not only are data on experience, observation, inspection, reading, and listening put into writing, but also key words, suggestions for illustrations, stimulated thoughts which have a direct bearing upon the deductions. Note taking, therefore, should never

be a mechanical matter. The mind, as well as the hand, should be working.

NOTES A BRIDGE BETWEEN FACTS AND REPORT

After the topic has been determined by drawing on one of the four sources of information, the first step for writing is to make thoughts tangible. They become so when they are the isolated words, phrases, sometimes even sentences, that occur to the prospective writer as he thinks through his facts before he makes an attempt at organizing and assembling them into any connected discussion. These words, phrases, and sentences are notes, *i.e.*, the ideas in their crude state. They later will be refined and shaped into a smooth, interesting, precise piece of writing.

QUALITIES OF GOOD NOTES

The form for recording data, *i.e.*, the system of arbitrary words and signs used in preserving facts, varies. The statement is often made that notes need to be taken in a form that is clear only to the recorder. If he can be certain that he will always recall the meaning of his own "short-hand" system, this is good advice. Leonardo da Vinci, the great scientist, used for his voluminous notes and musings mirror writing, to make them less clear to others; but in most note taking for practical use the scientist wants his data in easily accessible form—so clear that they can be read accurately months, even years, after they have been taken. Notes, therefore, must be intelligible after they are "cold"; they must also be sufficiently extended to give accurate information when the surrounding circumstances have been forgotten. They are evidence that is valid, no matter how much time has elapsed since the recording. Under no circumstances should notes be ambiguously or equivocally set down. The notes on inventions, new discoveries, environmental conditions that affect life and death, progress on work, are only a few instances among the many that demand extreme accuracy.

Since note taking is so vital in scientific procedure, to recommend that data be preserved in a form that only the note taker can interpret does not seem sound advice. It implies falsely that he will always remember what his particular system of recording signifies. It often makes him careless, too, for he will have a tendency to put too much dependence on his code; thus, he is likely to slight some significant

features. He thinks at the time, however, that he can read meaning into the peculiar symbols and signs which he has adopted for preserving data. Consider how easily a stenographer who does not use shorthand daily forgets the signs and symbols. Note taking is good only if the notes are clear after other things and other thoughts have intervened.

The student can check his ability in note taking the next time he reviews the notes of a course in preparation for a midterm or a final examination. As a still more conclusive test, he should look over some notes that were made months before and see whether he knows what information they were intended to preserve.

KINDS OF NOTES

Notes in college take various forms. In many scientific courses, there are standardized methods. Data derived by testing and recorded under specified printed headings are notes. The figures must be legible and accurate; they are seldom transferred to other sheets, both because there is the danger of error in copying and because copying is a waste of time. Handling these record sheets in the laboratory may leave them a little grimy; but when the sheets must be used to make the calculations for deductions that are the basis for discussion, these figures can be read. For convenience, printed forms are also used for notes in commercial laboratories and clinics. However, the details of the particular case always require additional comment. If a large volume of work is handled daily, the first notes, obviously, must be in accurate, clear, and final form. Forms for notes on reading have been given in Chapter Two and will be further discussed in Chapter Thirteen. The student while in college should take every opportunity to develop skill in routine note taking; he can apply it in his professional practice. He should use a form, if it is available; otherwise, he should make up a form, especially for the notes on routine activities.

SELECTING THE DATA FOR RECORDING

Not only figures but also descriptive details and actual methods of doing work need preserving. Take, for instance, the notes on the fact-finding stage of any activity at its beginning, and during its development, such as the construction of a building or the growing of a crop. Notes should be taken on the conditions at the start, at the different stages of construction, or growth, and at the completion of

the work. In many kinds of professional activity, particularly outside work, field books are kept. These books are of pocket size, and are well bound so that they will stand wear and tear in the field. In them are recorded conditions, measurements, and other pertinent data. These are the basis for later analysis, as well as records of existing conditions. For inside work, data sheets have more extended use. They are often made into loose-leaf notebooks. To expedite recording, the details have been classified under appropriate headings, and the recorder, or note taker, inserts particular data as he experiments, observes, or inspects. These data sheets usually form a part of a formal report, for not only are they the notes that preserve in writing the manifestations of the scientific principles under scrutiny, but they also serve as the scientist's factor of safety, should his conclusions and recommendations be challenged.

The observer may or may not have some standardized way for "taking his pictures," but the inspector, especially if he has observations or visits to make daily, will usually have a printed form on which to record his facts. These forms preserve data peculiar to his work, as well as covering a particular activity within it. Consider the blanks that are in evidence when a person enters a hospital or when he takes a small pet to the clinic; the daily check that is kept on a construction project; the record that chronicles the growth of a crop.

NOTES ON LECTURES

Notes taken on experience, observation, and inspection are on activities the details of which the participant must select, analyze, and apply according to his judgment and training; they have to do mainly with tangible things. For taking notes on lectures, seldom are any formal helps given or available. The most successful lecturer puts his material in such form that his hearer can recognize the logical sequence, and emphasizes important ideas that are "notable." He will not always, however, tag them as those which the student should record for future reference. Sometimes, outlines of lectures are distributed; but in most cases, in taking notes on reading and on lectures, the student must discriminate between the ideas that should be taken down and those that make the discourse vivid but are not so essential. For instance, it is always good practice to make a note of the illustration that best explains the principle to the particular note taker. Of course, the same example or figure does not have the same

appeal for all or make the principle clear to all. One good way of getting the right ideas recorded is to be on the lookout for definitions. They are always worth preserving. Definite dates, actual measurements, working formulas, facts, and theories, the one or two significant generalizations—all these are other important data for record. For the method, content, and adequacy of the notes on lectures, the student may go over those he has taken in one or more of his beginning courses and see if they meet the specifications for accuracy, clearness, and stimulation of more extended thought.

He should always head them with a definite topic and date them. A convenient form might be:

> Chemistry 401: Lecturer, Professor Blank, October 15, 1938
> Subject: The Atomic Theory

If the course is one in which several persons give lectures, it is especially desirable that the subject of the particular lecture and the speaker be recorded. The facts of identification are as necessary to adequate lecture notes as is the recording of the author, the title, the chapter, page, and date of publication of a book or magazine with notes on reading.

READING NOTES

There are few definite specifications given for the identification and recording of notes on reading, though often the list of questions that the assignment will answer can be used as a guide. Listing chapter headings and subdivisions within the chapters will also aid. Concise summaries of what has been read, followed by personal comment and reaction, make sure that the student has understood what he has read, perhaps even seen a definite relationship to the other learning methods of the course.

Notes on reading may be illustrated by those which might be taken on any chapter of this text. A special example, however, will be the notes that a reader might make on Chapter One if he were getting ready for an examination or had to write a discussion of the ideas of the chapter.

These notes touch the high points of the chapter. From them, the note taker should be able to reconstruct the extended discussion of the chapter for any required purpose. Every person would have, of course, his individual method of jotting down his notes, but he would

record the same general points in spite of the difference in phrasing. Some might make more extensive notes; some might reduce them slightly. There is room for individual preference here. The illustration given below should be regarded only as a sample method of note taking on reading. Too scanty notes, when referred to later, do not make for deepening thought; too many develop no capacity for picking out the important points; yet these, reduced to their lowest terms, are what should be retained out of the reading of the chapter. Around them, the whole discussion is focused. They have meaning to the individual only as they are identified by the reader as related to his own situation. To these important points, when the chapter discussed has "touched off" his thought, he will bring more and more frequently his own examples, to make vivid and clear the principles and generalizations of the chapter.

Notes on Chap. 1, *English for Students in Applied Sciences*, Harbarger, Dumble, Hildreth, Emsley, pp. 3–9, McGraw-Hill Book Company, Inc., New York, 1938.

The applied scientist's need for English
- necessary in the practice of his profession
- inventory of weak and strong points in writing helpful at beginning of college course. May be grouped under 5 items on the mechanics of writing; under 2 on the thoughts that prompt writing.
- qualities of good scientific writing—clarity, vividness, emphasis
- very necessary to have subject matter of individual interest
- writing demands in college course similar to those required in profession after graduation
- *study of the report very important*
- reports of experience, of observation and inspection, of simple research
- college reports, midterms, written quizzes, final examination excellent preparation for future writing

USEFULNESS THE FINAL TEST OF NOTES

The best indication, perhaps, of the adequacy of notes is their extent and detail, *i.e.*, notes on reading should be sufficiently detailed to record the kernel of the underlying principles and abstract generalizations of the subject under discussion, with enough details in the way of concrete facts, figures, examples, and definitions to represent accurately the author's statements and point of view. If any

statement because of its phrasing could be misunderstood, it may be copied verbatim with sufficient explanation to show what preceded and what followed this startling statement. It is extremely unscientific, as well as unethical, to quote a startling statement without giving its setting. A verbatim copy, of course, should be identical with the original, down to spelling, capitals, punctuation.

RECORDING DATA OBTAINED THROUGH EXPERIENCE

Note taking on experience means the setting down of the outstanding recollections of the work actually participated in after the work has been completed and a brief time has intervened. Thus the work can be surveyed as a unit. When notes are made "on the job," they are to all intents and purposes notes on observation. They come under experience, in this case, because the recorder is noting his work as he does it. Because he has been so close to his activity, it is extremely difficult for him to see the whole of his work in perspective and to sift the essentials from the nonessentials. His notes are the result of thinking through the work, discovering the details that stand out, determining their relation to the work as a unit, then recording them in a form that will provoke further thought when the complete account is being written up. Assume, for instance, that a student has made an airplane model and wants to write an account of his work. In his mind, he will cast about first for the significant features, such as design, materials, actual construction, uses, results. In imagination he will build again the entire model. As different details occur to him, he might preserve them for later use in some such form as this:

> Design: monoplane
> Dimensions: 12 in. long, 14 in. wingspread
> Materials: balsa wood, parchment paper, wire, glue
> Parts: propeller, wings, body, struts.

After he has made notes on all he has remembered, he might refer to some article on model building to check his memory; but *reading about how something is made or done comes after the actual experience.*

Or if the student has had work in industry for a vacation, and is asked to report on his experience, say in 3000 words, he could start by jotting down as his first notes the following;

place, date, firm
product, use, market all over the world
my job, first as laborer, then as helper in the shop
some details of my work unloading cars
the people I worked with in the yard, foreign born mostly from southern European countries
the results of this experience, some money to start college on, some knowledge of actual industrial conditions.

He will then check these items through, to see whether all of them are to be included in his report. He may find that some are not relevant; that others are so hazy in his mind that he cannot write more than two sentences without further thought—without perhaps a visit to the shop, if it should be near by; that some very important facts have on first thought been overlooked. Regardless of how general his first notes in black and white may be, however, they will indicate to him how thoroughly he mastered his work and understood his experience, and meager though they are they should "touch off" his thinking and extend and vitalize his thought. From these notes, extended and organized, the outline, discussed in detail in Chapter Four, is evolved.

RECORDING DATA ACQUIRED THROUGH OBSERVATION AND INSPECTION

First notes on observation, which may either be taken "with the eye on the object" or set down later from mental notes when it is not convenient or desirable to put them in tangible form at the exact time of the observation, might be illustrated by those for an account of the locks at Sault Saint Marie, Michigan:

1. General impression, well-kept grounds, inconspicuous structure
2. Two hours of watching freighters go through
3. The locks, deep concrete-lined channels with immense gates at either end which can be opened or closed, depending whether the freighter is going up into Lake Superior, or down into Lake Michigan. 4 of them, only 2 in use at the time I saw them
4. The principle of operation
5. Machinery, simple, electrically operated, housed in small houses. One set for each lock. These houses very clean as all power houses. Switchboard, operating levers in evidence. Only a few men needed to

do the actual operation. Seemingly only a matter of pulling a few switches and levers
6. The purpose of the locks

The observer in this instance was a tourist who had only a short time at his disposal; hence he could not get great detail, but only the visible methods of operation and conspicuous features of the layout of the locks. There were, of course, more that might have been noted or remembered that would stimulate thought and make writing more easy, after he had watched for two hours the great freighters moving through the locks.

Inspection, as has already been pointed out, is merely the combination of experience and observation. Notes in such work are usually the data, recorded under appropriate headings on standard blanks, that belong to the work.

SUMMARY OF SPECIFICATIONS

Note taking is not verbatim putting down the words as the stenographer takes dictation, nor is it the actual word-for-word copying of pages of printed matter. It should be a selective procedure, a taking down in convenient, clear, accurate form, of the essential information, for ready reference and later application. Regardless of whether the data to be preserved represent experience, observation, inspection, reading, or lecture, accuracy and accessibility, the chief requirements of note taking, cannot be overstressed. Illustrations of the procedure peculiar to each will be found in those chapters of the text which discuss the report of experience, of observation and inspection, and of simple research.

No matter what the form or what the source, the student should be exceedingly scrupulous in recording facts for preservation and for the deductions of other facts. He should never relax his vigilance in maintaining the accuracy of his data, the keenness of his observation, the thoroughness of his inspection, and the carefulness of his reading so that he gets the author's intended meaning. It is unscientific to jump at conclusions. "Touching off" thought only means understanding what the author said; then with this material as a starting point, discovering what ideas are kindled in the reader's mind that will confirm, disprove, or illustrate the author's thought. Thus does the reader come to possess the ideas of his reading so that he

can apply them sometimes as they stand, sometimes with modifications, sometimes even through rejecting them entirely.

Problems

1. Take notes on a lecture in one of your courses; then check them to find out what type of items you have recorded—facts, figures, formulas, definitions, illustrations. Be sure to use the heading for lecture notes that is suggested on page 31.

2. Jot down, after the manner of the example on page 32 notes for a chapter in your textbook in chemistry; on a magazine article that you have recently read; on a short story; on a chapter in this text on English.

3. List five activities in which you have had experience, such as building a boat, a canoe, a locomotive, or an airplane model; growing a crop; setting up a camp; target shooting; an interesting procedure in some commercial or industrial work. Then record rough notes for two of them. Set down *all* the items that occur to you in connection with each of these two. If you can group them under some two or three heads, do so; but in this first assembly, it is more necessary to discover what is in your mind than to put your information in order.

4. Observe and make notes upon the general impression and the outstanding features of one of the following:

- *a.* The campus from the main entrance; the football field from the 50-yard line; the baseball diamond back of the pitcher's box.
- *b.* The procedure in the demonstration of a chemical principle, such as chemical conduct of the common cation.
- *c.* The arrangement of a current or permanent exhibit in a museum or a library.
- *d.* The arrangement of a display in a window of a bookshop, a store selling sporting goods. Consider in displays of this type their relation to the season and the interests of a particular community, such as a display of books by a local author, books for Christmas giving, equipment for winter sports. Test out your power of observation by taking mental notes on these arrangements. That is, do not set down your notes while you are making your observations, but do it later when you have only your memory to depend upon.

Chapter Four

Outlining

ORDERLY ARRANGEMENT OF MATERIAL

Outlining is not an exercise detached from report writing. It is a part of report writing. The first outline of a report is, in reality, the first copy of the report. It is the first orderly arrangement which the writer gives to his material. The work, from his first arrangement of what is likely to be meager material to the finished report, is one continuous process.

SELECTING THE SUBJECT

However, before there can be any classifying or arranging, a subject must be selected. The subject will result from the writer's own interest or from a teacher's or a supervisor's conviction that it will be profitable for the writer to select a certain subject. In either case, the writer should, first, carefully scrutinize his subject to see that it is properly limited. He may limit it after deciding upon the following points:

1. What is the approximate number of words that he will be permitted to use?
2. What must be covered in the report if the subject is to fulfill its promise to the reader?
3. What, exactly, insofar as he knows at that time, is he attempting to prove, disprove, exhibit, or discover in the projected study?

After he has carefully decided upon what the answers to these three questions shall be, he may find that his subject is not suitable. If, for example, he has selected or been given the topic "Independent Suspension of Springs on Automobiles" and has tentatively decided upon his phrasing for his exact title, he will find upon careful analysis that the subject is so broad that a report upon it, to be of any value whatsoever, will have to contain many thousand words. If this report is to be read to an audience in a certain set time, say half an

hour, or is to appear in a magazine in a moderate space the length of which has been determined by the editor, or is to involve a restricted amount of intensive research which an instructor may think proper for a specific course, then he must limit the subject. In other words, he must take one phase of it—one that can be so treated in the specified time or space that it will be of value to both the reader and the writer.

If the instructor has allowed 2000 words for the report, the student might choose the following phase of the general subject, "The Introduction into America of Independent Spring Suspension on Automobiles." Before he starts work, he should decide upon a tentative title, for such a decision will force him to analyze his subject and, if it is too comprehensive, to limit it.

THE DIRECTIVE OUTLINE

This very act of thinking the subject through to a tentative but definite title is an important preliminary step, for it brings before the writer in sharper focus what will probably be the main parts of the yet unwritten paper. As these main parts are revealed, they should be put down in black and white; when they are so recorded, the second important step in the writing of the report is completed.

It is not always necessary for the writer to make his own preliminary plan. Often the instructor, the editor, or the officers of a meeting will give the writer a list of main points which they wish him to cover in his report, article, or talk. These main points are generally in outline form, with the main points further divided into subpoints. Since the purpose of such an outline is to direct the writer in his search for information, in its selection, and in its presentation, the name given to this list or outline is "directive." But whether the writer receives such an outline from the person requesting the writing or whether he forms it himself after a careful analysis of his problem, it is still a directive outline. And it serves in either case as the most essential part of a good beginning.

If the writer makes it himself, he is likely to find that this second analysis discloses weak points in his subject. For example, in preparing a directive outline for a report of 1000 words, he must limit the number of main divisions. If the writer finds that in his directive outline for such a paper he has ten main divisions, he sees at once that he can give, on the average, but 100 words to a main division—

possibly, at most, seven or eight sentences. It is seldom that such a limitation will permit any degree of thoroughness, and as a result the paper will be of little value to either the writer or the reader.

LIMITING THE OUTLINE

In case the writer finds more main headings in his directive outline than he thinks can be handled adequately in his predetermined space or time, he should do one or two things. First, he should check the directive outline to see whether the divisions are all of approximately equal importance. He may find that some items which he has selected for main divisions are, in reality, only parts of another division already made. Or he may find that some of his main divisions can be completely eliminated without preventing his achieving the results after which he originally set out. If this rechecking fails to bring the number down to three or four main divisions, he should consider a new basis of division.

If, for example, he is preparing a 2000-word report on "The Development of Automobile Tires Since 1920," and has drawn up the following directive outline:

I. Goodyear
II. Goodrich
III. General
IV. Seiberling
V. Firestone
VI. United States
VII. All State
VIII. River Side
IX. Mohawk
X. Miller

he should see at once that the treatment of each topic will be fragmentary, and even then must contain much repeated material, since tire manufacturers are quick to repeat each other's successes. However, a new directive outline such as the one which follows will eliminate this repetition.

I. Solid Tires
  A. All rubber
  B. Filled

- II. High-pressure Tires
  - *A*. Fabric
  - *B*. Cord
- III. Low-pressure Tires
  - *A*. 25–35 pounds
  - *B*. 10–15 pounds

In this outline, between 500 and 800 words can be given to each section without slighting or taking space from another section. Furthermore, in following such an outline, the writer is not tempted to repeat material which has been illogically divided.

Collecting Facts.—Now, having determined the general direction in which he is going and what in general he knows about the subject, the writer is ready to begin collecting facts. The system of collecting facts on note cards which are classified according to the directive outline is discussed in Chapters Two and Thirteen.

THE FACTUAL OUTLINE

As the writing process is carried further, the directive outline is gradually changed into a finished or factual outline containing the facts which have been collected by the writer. During the period of fact collecting and fact arranging, the directive outline will probably change many times as facts are added to its bare form—as it takes meat onto its bones. When the writer discovers new facts, gains new points of view, and interprets new information, he may see more desirable ways of arranging his information. He may even select some new basis of division and change the entire direction of the report.

After the directive outline has been revised, remolded, rearranged, and filled with collected facts, and so has become a factual outline, there remains yet another possible revision before the writer starts changing his topic facts into sentences and paragraphs and thereby writing the paper proper.

This expansion is undertaken with the reader or listener in mind. Up to this point, the writer has collected and sorted facts with one purpose before him: to gather together the important facts and truths pertinent to his subject. Now, he must decide how these facts may best be presented for his particular audience. No hard and fast rules can be given for this part of the work. Each case requires its separate handling. (A complete discussion of this process is to be

found in Chapter Six.) The order of the outline may need changing, certain parts may need more space, or further research may be necessary to simplify and clarify certain points. Parts may be deleted, if in this analysis for reader appeal the writer decides that they are unnecessary in the gaining of his end.

After the final decisions have been made concerning the relationship of the report to the reader, and the outline has been revised if revision is necessary, the writer is ready to expand the outline into a report.

MECHANICAL STRUCTURE

From the selecting and limiting of the subject to the point where the writer is ready to expand his outline topics into paragraphs and sentences, and therefore into a report, all of his facts have been in the form of a framework.

They were placed and kept in the form of a framework or outline for several reasons:

1. Material in an outline is more flexible than material in paragraphs. It can be shifted about more easily when occasion demands.
2. The outline helps the writer keep a proper proportion between his parts. If one part of the outline is growing too large and promises to take up more than its share of the space in the finished report, this abnormal growth becomes plainly visible in the outline and can be checked.
3. It provides a simple means of classifying information.
4. It keeps the writer from straying from his subject.

If the outline is to do all these things, it must itself follow certain rules and regulations of composition. These regulations must be observed for the sake of clarity, straight thinking, and convenience. There is no place in the outline for originality in form. Originality must come in expression and interpretation of ideas in the finished report. The standard form has the following requirements:

1. *Spacing*. The outline must not be crowded on the page. There should be ample margins on all four sides. It should not be single spaced.
2. *Indenting*. The purpose of indenting is to show the relation between parts. All outlines should be indented exactly as the model presented. If subtopics are not set to the right of important topics the reader does not see them in their proper relationship, and consequently does not give them their true value. All topics of equal value should be indented exactly the same distance. For example, in a clear outline the small

letters of the alphabet should be so lined from top to bottom that a straight line drawn perpendicular to the bottom of the paper and passing through one of them would pass through all of them.

3. *Lettering.* The most common and most practical form of lettering is that displayed in the sample outline. It consists of the Roman numeral, the capital letter, the Arabic numeral, and the small letter, each used to indicate a specific degree of topic subordination.
4. *Complete division.* A thing cannot be divided into one part. If a division has only one subdivision, a mistake has been made. One of two things is wrong. Either no actual division has been made, or the division is not complete. If no actual division has been made, then the topic intended for a subdivision is in reality merely a restatement of the heading which was to be divided. If, on the other hand, the single topic, upon examination, proves to be a part of the divided topic, then the division is not complete: there are other parts of the divided topic to be recognized and written down.

   A good way for the student to test a division for completeness is to see whether the subpoints when taken together equal exactly the main point under which they fall.
5. *Parallel structure.* Coordinate parts of the outline should have the same grammatical structure.
6. *Proper coordination and subordination.* An outline must show the relationship of the parts to the whole. Parts of a topic must be placed under the topic which has been divided. Parts of equal value must be placed in such a way that their equality is indicated.

The following outline illustrates proper form. It may be taken as a model for:

1. Spacing
2. Indenting
3. Lettering
4. Complete division
5. Parallel structure
6. Proper coordination and subordination

OPPORTUNITIES FOR WORK IN THE DIVISION OF HOME ECONOMICS

I. Dietitian
   A. In a hospital
      1. Head dietitian
         a. Oversees all work done
         b. Makes all plans

2. Assistant dietitians
   a. Help head dietitian
   b. Carry out plans of head dietitian

B. In a restaurant
1. Oversees all work done
2. Makes all plans

II Home Demonstration Agent

A. Work in county
1. Visits club meetings
2. Visits families throughout county

B. Work in office
1. Correspondence
   a. With members of county
   b. With members of extension offices
2. Meetings
   a. For club members and leaders
   b. For leaders of county organizations

III. Teacher

A. During school hours
1. Helping pupils
   a. During recitation period
   b. During laboratory period
2. Discussing *problems and methods* with other members of faculty

B. After school hours
1. Holding meetings
   a. With parents and friends
   b. With other teachers in county
2. Attending meetings

IV. Costume Designer

A. Sketching of clothes
B. Modeling of clothes

V. Value of training in home economics

A. To those in the home
B. To those out in the world

Problems

1. Make a topic outline on "My Home Town" or "______________________ University." Test it for: (*a*) parallel structure, (*b*) completeness of division, (*c*) proper coordination and subordination.

2. Outline the same subject again, this time using a new basis of division, that is, use the same subject matter, but different main topics.

3. Transform your topic outline into a sentence outline.

4. Compare the two outlines. Which one best meets your needs? Why ?

5. Make three outlines of one subject, each outline adapted to the needs, interest, and understanding of a special audience.

6. Rewrite the table of contents of a textbook in strict outline form, taking your subtopics from the paragraph headings of the book.

7. Suggested topics for practice outlines:

   a. College sports
   b. Extracurricular activities
   c. Methods of travel
   d. Kinds of farm machinery
   e. Tools for woodworking

8. Select a subject. Then limit it and give your reasons for the limitations.

Chapter Five

Kinds of Functional Writing

PROGRESSIVE WRITING

Every piece of writing has a first draft. For most professional writers, the first draft is only the beginning, and the final copy is the end of a series of tryouts. Progressive writing resembles modern improvements in roads, whereby narrow, winding lanes of the countryside become straighter, wider, and safer.

The number of drafts that an extended piece of writing should go through before it is released in the final copy to the reader cannot be definitely specified. They depend upon the time allowed to complete the paper and upon its purpose. Like the rough outline, the first, sketchy draft may be of little use except to the writer. After a second, a third, a fourth, or more versions, the instructor or the critic receives a form which is practically complete. It is still to be looked over for correction or improvement, though it is already transformed from the topics of the outline, the design, into the paragraphs, figures and tables, and language of the connected copy. It must be finally tested and challenged as to its probable performance when it shall be put into actual service, just as is any piece of mechanism.

All work done before the first draft, even though it consisted of actual writing, was auxiliary and preparatory in nature. Notes on observation and research made inventory of the materials available for use; the formal outline was a blueprint of the desired result. In passing from these preliminary stages to progressive writing proper, the writer first shapes and fits in the actual parts which will appear in the final copy, in the appropriate, complete form of functional writing, such as a letter, a report, or an article.

The terms of rhetoric usually applied to these forms and their parts are the whole composition, paragraphs, sentences, and words. For all practical purposes, sentences and words may be grouped

together under the more general heading of language. To them must be added figures, tables, and other special parts which are not entirely made up of language, and which are not arranged after the usual manner of paragraphs. These graphic parts have a wide range of size, form, and use. Some, like graphs and pictures, may be larger than paragraphs; some, like scientific symbols, may be smaller than words. Most of them lie midway between paragraphs and sentences, in both size and function. Their value in scientific writing is so great that, even though they might be called accessories to ordinary written matter, they are essential, as an adding machine is essential in a bank, or a radio in a police automobile.

The *basic problems* of progressive writing up to the stage of revision for the final copy are:

1. To determine what kinds of "whole composition" are standard in professional use, and what characteristics they show.
2. To amplify the topics and subtopics of the complete formal outline into the various types of paragraphs in sequence, with the help of figures and tables.
3. To make effective statements within the paragraphs and partly within or closely connected with the graphic parts, by means of language; *i.e.*, by sentences, clauses, phrases, and words.

Each of these problems will be given extended discussion in succeeding chapters.

In all of these problems, as in scientific work in general, a large part is played by *standard requirements*. It is always advisable first to find out what is the regular procedure in professional practice, before experimenting with optional features. For example, in the work of practical scientists and in that of students, a report usually grows out of an assignment. Specific description of data may compel the use of tables, full paragraphs, and complex sentences. Technical terms, like *voltage* or *colloidal states*, have no synonyms. The writer may have the choice of explaining them for general readers; but he does not always have the right to omit them. Demands of this definite type make scientific writing more difficult than ordinary expression, yet in another way, easier, because the requirements are so often exactly specified.

The student facing the first draft has already tentatively selected the kind of writing he will use in his "whole composition" but may still find it advisable to change. A progress report, for instance,

might be boiled down to a memorandum, or by the reverse process of expansion result in a striking article for the student technical journal. For such readaptation of material the various kinds of functional writing must be known. In most cases they will need to be reviewed. This readaptation to conform to a change of "whole composition" is required by the relation of the writer to the reader. Some of the types and characteristics of the functional writing that the technical writer is likely to use as he develops from student to expert scientist might be set up thus:

Writer	*Reader*	*Type of writing*	*Characteristics*
Student technician	Instructor	Laboratory reports Examinations Student petitions Professional letters	Clarity Accuracy Organization
Expert technician	Student	Textbooks Lectures Laboratory directions Specifications for class papers	Clarity, accuracy, organization Development by comparison and synonyms Interest
Expert technician	Expert technician	Theses (graduate) Professional journal material Professional society papers Research bulletins	Clarity, accuracy, organization Utmost precision (technical language) Explanation of data
Expert technician	Layman seeking concrete information	Experiment station bulletins Reports to administrative groups Grange discussions Radio papers	Clarity, accuracy, organization, interest Conclusions and recommendations stressed rather than details

The classification might be further extended to include the literary scientist as the writer; the general public as the reader; the types of writing as nontechnical articles, and reports of observation, inspection and interview; and the characteristics as accuracy, interest, vividness, and careful selection of significant details.

In the case of letters and reports, the purpose is actually double rather than single. (1) The facts must be put on *record*, for reference when needed. (2) They must be *easily read*. A bulletin on Common Binder Head and Knotter Head Troubles, for instance, is accompanied by the direction: "Keep this bulletin in the tool box for ready references during the harvest season." The dual function runs through most kinds of practical writing.

Ready reference means at least quick and easy reference. Any printed matter containing practical instructions must be legible, orderly in arrangement, and clear. In these respects, it begins to take on the character of a *readable* document. Readability covers a wide range across the border line into "creative" writing, but even in practical work it cannot be neglected. The importance of *readable records* will become increasingly evident as the kinds of functional writing are surveyed.

ASSIGNED TYPES

In the detailed study of the kinds of functional writing, the first point to observe is that all this writing is largely the outgrowth of assignments. The student who finds definitely specified writing irksome should note that he often has more freedom of choice than the professional writer. In college work, it is the type which is required rather than the subject. For reports based on experience, inspection, or research, the student may range over a score of industries or sciences within the limits of his knowledge. In the world of production and employment, the technical man must deliver the expert information on a problem in his field, as directed by employer or client.

Information of such a practical nature is communicated in reports. If these are long, they will be accompanied by letters of transmittal; if short, they may be condensed into letter form. Letters and reports make up the bulk of professional writing. They differ mainly in the matter of personal or impersonal tone, the former of which is more suitable to letters.

Professional Letters.—Letters are usually classified as business and friendly ones. The term *friendly* is better than *personal* because all letters, practical as well as social, are personal, or should be. But practical correspondence is not always commercial. The term *professional letter* is proposed here for the kind of communication

which should have all the businesslike qualities of the better commercial letter, plus the concern with scientific information and expert service which belongs to the professional worker.

A good letter writer is a good man writing letters—to adapt the old Roman's definition of the orator. The job calls for experience, education, character, courtesy, judgment, and the knowledge of certain rather rigid essentials of good English and clean copy. For special requirements, the student should consult his English handbook and some standard work on business correspondence.[1]

A good professional letter of any practical type not only provides a *record,* but creates an *impression.* Imagination plays its part. The problem is to foresee and answer questions which the reader is likely to ask himself or, better yet, give the reader every opportunity for answering them. For practice, writing personal letters as well as practical ones is of great value in developing informal and human style. Everybody is glad to receive a friendly letter. If we write familiar letters habitually, and try to write them well, the curse of self-consciousness will gradually be lifted from our workaday correspondence.

For the letter as a record, the information must be complete and accurate. Reference to the occasion, statement of the purpose and the essential facts, and provision for further communication, are usually needed. A method of testing completeness and accuracy in letters is the legal test. Imagine that your letter will come up as evidence in court. The heading, inside address, signature, and indication of enclosures no longer seem like overstarched formalities. Names, dates, addresses, and all other details become matters of money, reputation, contract rights, and justice.

Excluding the unwelcome event of a scene in the courtroom, we may also learn something by imagining the everyday routine of a business office. Letters are opened and the envelopes are usually thrown into the wastebasket. Separate pages, if not clipped, may be parted and mislaid. The addressee cannot take up a telephone and ask "Who is talking, please?" All the needed information, especially the personal facts, must be before him in black and white.

[1] For general introduction to the problem and for a delightfully human interpretation of it, students and instructors will thoroughly enjoy Thomas Arkle Clark's *When You Write a Letter*, Benjamin H. Sanborn & Company, Chicago, 1922.

The requirements of good form and good usage in professional letters are so strict that it is harder to write good ones than to prepare any other form of composition of equal length, with the possible exception of a list bibliography.

Though there are sometimes variations, such as open and closed punctuation, the preferred setup of the professional letter can be reviewed by reference to the examples on pages 51–52. It can be further confirmed by reference to current letters from organizations that give careful attention to the display and layout of their letters and have progressive, yet not extreme, correspondence specifications.

The particular type of professional letter for which the report writer has constant use is the *letter of transmittal*. Its main purpose is to announce the subject and the authorization of the report. It also often notes and explains any conditions that have markedly affected the procedure. It justifies presentation by indicating the reader intended, and acknowledges aid from people and the use of printed material. It is the report writer's factor of safety. In it he explains inclusions, omissions, limitations, and general treatment. It is similar to the preface of a book. The letter, however, is addressed to an individual or to a definitely designated group of readers. The preface is by no means so definitely focused, but rather "to whom it may concern." Because of the similarity of basic purpose, however, the student can extend his understanding of the function of the letter of transmittal by studying the prefaces of his textbooks.

The student who presents in person a piece of writing to his instructor with an oral statement of just what the assignment has been, some comment upon his aim, the problems he has met, his success in solving them, and a courteous request that the paper be accepted by the instructor, accomplishes by word of mouth the same end as the letter of transmittal.

The examples which follow show not only the usual format of the professional letter but also the contents of a typical letter of transmittal. There are other forms of setup and other arrangements of contents but, if no special form is specified, these are always acceptable. The contents of such letters in relation to the different types of reports will be presented later. For the present discussion of professional letters, an understanding of their main function is sufficient. Note particularly in the example the placing and arrangement of the heading, the inside address, the salutation, the paragraphs, and the complimentary close.

EXAMPLE: STUDENT LETTER OF TRANSMITTAL

13 South Hall
Franklin, Transylvania
April 5, 1937

Mr. John H. Town
Department of English
State University
Franklin, Transylvania

MY DEAR MR. TOWN:

In partial fulfillment of the requirements of English IA, I respectfully submit the enclosed theme, "Radio Repairs."

I chose this subject because I have been working in a radio shop for the past four years, besides tinkering with my own set and those of my friends.

In the writing of this report I am especially indebted to my uncle, who gave me my first chance at actual employment and professional experience in radio repair work.

This is not intended to be a highly technical treatment. The average reader, to whom it is addressed, is interested in common troubles which he can prevent by his own efforts or entrust to the radio repair man without unreasonable expense.

Your criticism on the correctness and the effectiveness of the report will be greatly appreciated.

Yours very truly,
(Signature)
William P. Kenton

EXAMPLE: PROFESSIONAL LETTER OF TRANSMITTAL[1]

McCOLL FRONTENAC OIL COMPANY
LIMITED

Inter-Department
Correspondence

REFERENCE

HEAD OFFICE,
November 17, 1936.

Mr. J. A. Wales,
Vice-President.

DEAR SIR:

I am enclosing herewith Research Report No. 117 on "The Manufacture of Furnace Oil from Cracked Gas Oil" by G. P. Rankin and G. R. Taylor.

This report covers an investigation requested in your letter of June 25th, 1936 to develop a method of manufacturing stable furnace oil from cracked gas oil. A new process of manufacture and a recommended design for equipment for the Refinery have been developed.

The cost of manufacturing furnace oil by this new process is approximately the same as our present costs. In order to produce furnace oil

[1] Used by permission of the writer and the firm.

of improved stability, it is recommended that the equipment described in the report be installed at our Montreal East Refinery.

Yours very truly,
(Signed) G. R. Taylor,
Chief Chemist.

Letters have been compared to interviews. In the same way, a *memorandum* is a reminder corresponding to a short informal conversation, yet it follows a fairly definite form, in which the date, reader, writer, and object are very clearly shown. Though its purpose is to refresh the memory of the reader, it is also a record, and should be filed, at least for a while. Hence, we should not use the memorandum for trivial things. In student work the informal memorandum may replace the complete professional letter where exercise in formal correspondence is not needed at the moment. It is especially useful for brief reports of progress in preparation for long papers.

EXAMPLE: MEMORANDUM

Oct. 5, 1937

Subject: Special material for long paper
To: Mr. B. H. Jones, Instructor

Since conference I have received special data on new devices for preventing side-sway in automobiles, which I am presenting to be added to my notes on the long paper.

(Signed) William Patterson

A more formal official type of communication, directed usually to a college administrator, is the *student petition*. Since the form may be prescribed, the writer should consult his college office for particulars. If, however, there are no standard specifications, the professional letter form and procedure will be acceptable. The request, usually having to do with some change in curriculum, will succeed in direct proportion as it is clear in respect to what is wanted, sound in reasons given for support, and courteous in manner. Good taste is always noticed in letters; the petition is an effective test of good taste, because the petitioner is asking for a special privilege which he thinks is only his right. Everyone has something to learn about how to insist on his rights without being insolent, and how to ask a favor without "apple polishing."

The student petition which follows shows what should be included to make it an adequate presentation of the facts which prompt the request In some colleges, the practice is to omit Item 5, citing

references, and to present the petition with the signatures of the professors written across the lower lefthand corner to indicate their approval.

EXAMPLE: STUDENT PETITION

324 Lake Street,
Franklin, Transylvania,
March 26, 1938.

Dean F. M. Blank,
College of Engineering,
Transylvania State University,
Franklin, Transylvania.

I, Joseph Smith, Eng. 2, respectfully petition you and the Executive Committee of the College of Engineering for permission to elect Speech 418 (five hours) in addition to the 18-hour limitation, for the Winter Quarter, 1937–1938, for the following reasons:

1. My point-hour ratio is 3.
2. My general record in curricular and extracurricular activities shows that I can carry more work.
3. I have special need for extra work in English, Public Speaking, or Journalism, for practical use in sales promotion.
4. I am already engaged in such work summers with the F. T. Jones Co. of Cleveland, Ohio, and my need for this training is immediate.
5. The following instructors have kindly consented to let me use their names as references in support of this petition:
   Professor J. M. May, College of Engineering
   Professor T. O. Bay, Department of Speech, College of Arts.

Respectfully submitted,
(signature)
Joseph Smith

Reports.—Like letters, reports are addressed to special, not general, readers. The degree of conscious attention given in reports to readability will not be so high as in popular articles and books, but it should be equal to that of technical articles and books. Like letters, also, reports are to be filed. The question is: Will they be filed and forgotten, or will they arouse sufficient interest to make a favorable impression on client or employer? The young technician who can write well has a definite advantage.

Student reports are shorter and deal, relatively speaking, with less difficult problems than professional ones. Yet the general characteristics are much the same. The problem, whether assigned or chosen, will be timely and practical; the presentation will be precise,

clear, and to a certain degree interesting to the particular reader. Reports are more technical than letters, and less personal. Full discussion of the various types will be found in later chapters of this book, and for those who desire more advanced information, in standard works listed in the bibliography. However a few general requirements may be given here:

1. *The problem must be stated,* sometimes with a brief history, usually at the beginning, with or without the formal title of Introduction.

2. At the end, or often for convenience at the beginning, *conclusions and recommendations* are in order, with or without the formal label of Conclusion.

3. *Completeness* is necessary in reports. Though matter may be compressed to save space, essential facts must not be left out.

4. *Technical* features are required. Though there may be much explanation and illustration, high precision standards prevail, along with technical terms, formulas, graphs, and tables.

5. The presentation, like the problem, is *concrete*. Applied science deals with things that can be seen and handled. Tangible material of this kind can be made interesting without farfetched language. For example, on the topic of soils, vividness arises naturally from first-hand impressions of sight, touch, motion, smell, temperature, and even sound.

6. Finally, in spite of technical contents, a good report is always *clear*. The reader often lacks the specialized knowledge of the investigator and may be concerned with financial or public welfare questions, as well as with scientific analyses. Uses are vital, as well as results, and evidence can be simplified without losing its strength.

EXAMPLE: ARTICLE RESEMBLING REPORT[1]

MOSQUITO CONTROL ENGINEERING: II

MOSQUITOES: SPECIES AND HABITS

BY DR. THOMAS J. HEADLEE

State Entomologist, N. J. Agricultural Experiment Station, New Brunswick, N. J.

Before measures of eradication can be successfully applied it is essential to understand the biology of mosquitoes—Such knowledge will reveal their vulnerability and thus indicate methods for efficiency control

In any project for mosquito control it is proposed to do certain things which will result in such reduced numbers of mosquitoes that the population in the

[1] HEADLEE, THOMAS J., "Mosquitoes: Species and Habits," *Engineering News-Record,* 111: 199–201, Aug. 6, 1936. Reprinted by permission of *Engineering News-Record.*

protected district shall be free from further annoyance and danger from disease transmission. Past experience in mosquito control indicates that no project can be successfully prosecuted unless the engineer in charge first provides himself with knowledge of the species with which he has to deal and the habits peculiar to each species under differing conditions.

There is an enormous amount of variation in the habits, life history and activity of different species of mosquitoes. Some mosquitoes, under favorable conditions, will move as far as 65 miles from the places where they developed, others will move only a few hundred yards. Several varieties do not bite man and domestic animals. Some species lay their eggs upon moist soil, others

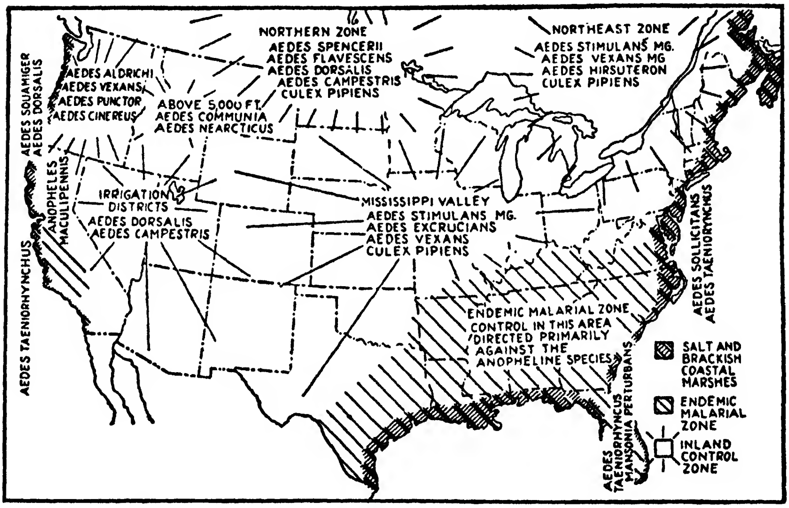


FIG. 1—DOMINANT MOSQUITO species and their general distribution.

only on water. During the winter months particular types survive in the egg stage, others in the adult stage and still others in the larval stage. Depending on the species, the selected medium for breeding-purposes may be fresh, salt or polluted water. Finally, only certain varieties carry disease—others are classified as pests.

In order to provide effective measures of control it is of utmost importance therefore, to know the different species and their habits under varying environmental conditions.

Principal mosquito species

The mosquito is a representative of the insect family known as Culicidæ and consists of two well-defined sub-divisions, the Chaoborinæ and the Culicinæ. The members of the Chaoborinæ are readily separated by the fact

that the mouth parts of the females are not fitted for piercing, while in the Culicinæ the mouth parts of the females are elongated and fitted for piercing and sucking. There is no practical interest in the Chaoborinæ or non-blood sucking forms. We, therefore, turn to the sub-division Culicinæ, all of which are known to suck blood or plant juices.

Under the Culicinæ in North America we find the genus *Anopheles* with 7 species, *Aedes* with 65 species, *Culex* with 11 species, *Theobaldia* with 6 species, *Psorophora* with 7 species, *Mansonia* with 1 species, *Uranotænia* with 2 species, *Orthopodemyia* with 1 species, *Megharinus* with 1 species and the genus *Wyeomyia* with 1 species, making a grand total of 102 species. Naturally only a relatively small proportion of the total number of North American species are of economic importance.

For the purpose of getting at a conception of how many species the mosquito control agent will have to deal with, the New Jersey situation may be taken as an example. There are now definite records of 35 different species of mosqµitoes occurring in this state. Of these, 6 belong to the genus *Culex*, 17 are *Aedes*, 4 are *Psorophora*, 4 are *Anopheles* and one each of the genera *Mansonia*, *Wyeomyia*, *Uranotænia* and *Orthopodomyia*. Of these species, 2 members of the genus *Culex*, namely *pipiens* and *territans*, 6 members of the genus *Aedes*, namely *vexans*, *cantator*, *stimulans*, *sollicitans*, *taeniorhynchus and canadensis*, 3 members of the genus *Anopheles*, namely *quadrimaculatus*, *punctipennis* and *crucians*, and one member of genus *Mansonia*, namely *perturbans*, are of great economic importance. This means that out of the 35 recognized species of mosquitoes in New Jersey, 12 are of real economic consideration.

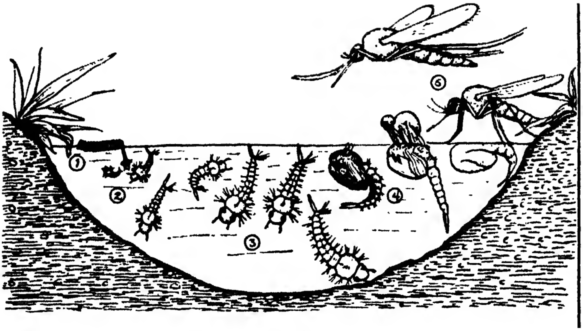
There is a considerable body of information available concerning the more important species of mosquitoes. This is all classified under the scientific name of the species and the only way the mosquito fighter can find out what is known is first to determine the species with which he has to deal.

Life history and habits

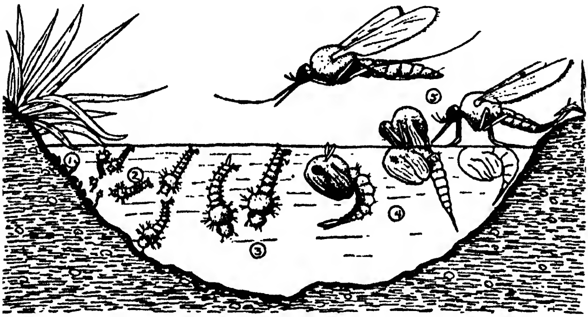
Hence, any person who proposes to undertake mosquito control operations must learn a great deal about mosquitoes, be able to identify species and know how to look up the facts regardless of where they may be published. The absolutely necessary key to unlock available information concerning mosquito species is a knowledge of the scientific name.

All species of mosquitoes have four definite stages in their life cycle, the egg, the larva or wriggler, the pupa and the adult. If, by any practical means whatever, one of these stages can be eliminated the mosquito pest disappears from the area in which it has formerly been prevalent.

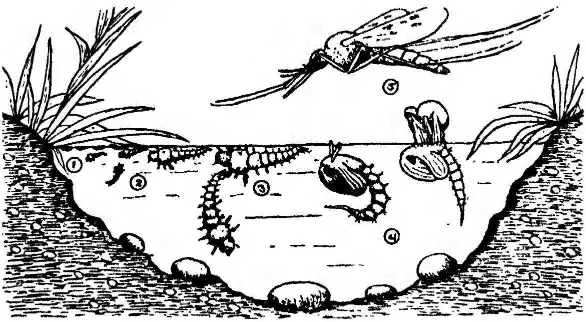
For New Jersey conditions it can be said that all economic members of the genus *Culex* and of the genus *Anopheles* pass the winter in an adult form and are notably decimated in number by the effect of low temperature and



House Mosquito



Salt Marsh or Woodland Pool Mosquito



Malarial Mosquito

FIG. 2—LIFE HISTORY of three typical mosquito species: (1) Egg stage; (2) hatching larvae; (3) grown larvae or wrigglers; (4) pupæ stage; (5) adults emerging.

exposure. All important members of the genera *Aedes* and *Psorophora* pass the winter in the egg stage and they are not reduced to any considerable extent by low temperatures and exposure. The single representative of the genus *Mansonia* passes the winter in the larval stage. The single representative of the genus *Wyeomyia* passes the winter in the larval form. Because of this great degree of freedom from destructive winter effects, mosquitoes of the genera *Aedes* and *Psorophora* can get on the wing early in large broods while *Culex* and *Anopheles*, because of the winter decimation, require considerable time in the spring to build up to a point where they are numerous.

FIG. 3—SALT MARSHES are well seeded with mosquito eggs which hatch in warm weather when they are covered with water brought in by high tides.

In general, the eggs of members of the genera *Aedes* and *Psorophora* are laid on moist soil rather than on water surface. Consequently, the rising and lowering of water level makes wide differences where the eggs are laid down. Any water level variation such as occurs regularly, as is the case with the tides, seems to afford the optimum conditions for the production of enormous broods. The eggs of the genera *Aedes* and *Psorophora* are resistant to dry weather, cold weather, wet weather, in fact to all the exigencies of climate. They may lie unhatched and will be viable in the soil for years. Then when the proper conditions arise they may hatch very promptly and develop enormous broods. It is, of course, rare that members of the genus *Psorophora* appear in large broods but that is because of the nature of their feeding habits.

The picture of the members of the genus *Aedes* runs somewhat as follows: Practically the entire surface of the salt marshes and of the exposed low-lying soil around bodies of water in the swamp areas as well as the bottoms and sides of temporary pools are seeded with the eggs of *Aedes*. These eggs will not hatch until covered with water of suitable temperature. On the salt marsh the hatching waters are brought in primarily by high tides. On the swamps and uplands and temporary pools the water originates in rainfall. Whether or not a great brood gets off is dependent on the length of time during which

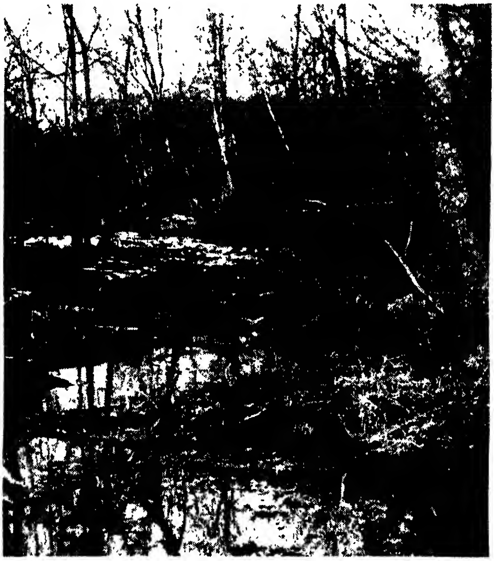


FIG. 4—WOODLAND POOLS and swamps are generally the first bodies of water to produce mosquitoes in the spring of the year.

this water remains and gives to the wrigglers not only a food supply but opportunity to gather it.

The eggs of the members of the genera *Anopheles* and *Culex*, on the other hand, are laid on water surfaces which are selected by the female as suitable places—these may range from pure spring water to the vilest sewage. However, very few of these genera can breed on the salt marshes and they find conditions suitable only at the inner and fresher edges; breeding is especially influenced by rainfall.

Factors affecting development

Once the eggs of the mosquito have hatched the question of growth, persistence and development of the larva is a matter of food supply in the

water in which it has been hatched and a continuance of this water. The food supply consists of unicellular animals and plants which are swept by the mouth brushes into the alimentary canal and then digested. Anything which prevents the development of this microscopic life results in the eventual destruction of these larvæ because they will die from starvation. The supply of unicellular animals and plants in water inhabited by mosquito larvæ is dependent upon the kind of bacterio-chemical digestion taking place in the pool bottom and that in turn depends upon the nature of the organic material in the bottom of the pool. Consequently, not all pools of water will support mosquito breeding.

Speed of larval development is dependent upon the temperature of the water. In midsummer *Culex* mosquitoes can complete the cycle in about a week, while in the spring or fall the same cycle may require three weeks. Among members of the genus *Aedes* the larvæ require from seven days in midsummer to four to five weeks to reach maturity.

The pupa, of course, takes no food but requires moisture for its persistence. This stage is usually short, varying from a day in midsummer to a week or ten days in cool temperatures of spring and fall.

When the adult emerges it sets out in search of food which, in many cases, is not blood at all but the juices of plants. Most mosquitoes can reproduce without blood. Furthermore, only the females can draw blood and the male must perforce live upon the juices of plants if he secures any food whatever.

Broods of adult females leave the places of breeding in search of food and also in search of new breeding spots. In this search these females may travel long distances. Salt marsh *Aedes* have been known to travel in New Jersey about 40 miles from a place of breeding, apparently going thither with the wind. On the other hand, *Aedes vexans* and *Culex pipiens* appear to travel distances only as great as ten miles and two and one-half miles respectively from the place of breeding, not going with the wind but rather in the direction of human population centers. The underlying causes of comparatively long distance movement of mosquitoes appear to be search for food and breeding places incident to the emergence of dense broods. The larger the emerging brood, the longer is apt to be the distance of migration. The activity thus initiated serves not only to continue the species where it is present already but to carry it to new breeding places.

Summarizing, it can be said that mosquitoes are organisms carrying on their life cycles in hidden, obscure and little visited places. Some live in uninhabited wilds, some in sparsely inhabited places and others in densely populated cities. It is therefore, an exceedingly complex matter to ferret out enough of these breeding places to reduce the mosquito population to a point where human comfort is adequately preserved.

Determining kinds and number

Before intelligent mosquito control work can be undertaken in any area a knowledge of the mosquito fauna characteristic of that area, throughout at least one season, and better two or three, must be obtained. An experienced mosquito fighter by making a survey of a given area and its environs can arrive at a pretty shrewd judgment of what the mosquito fauna is apt to be, but it is also easy to gain incorrect impressions.

Assuming that the paramount importance attributed to a basic knowledge of the mosquito fauna of the proposed protected district is justified, the

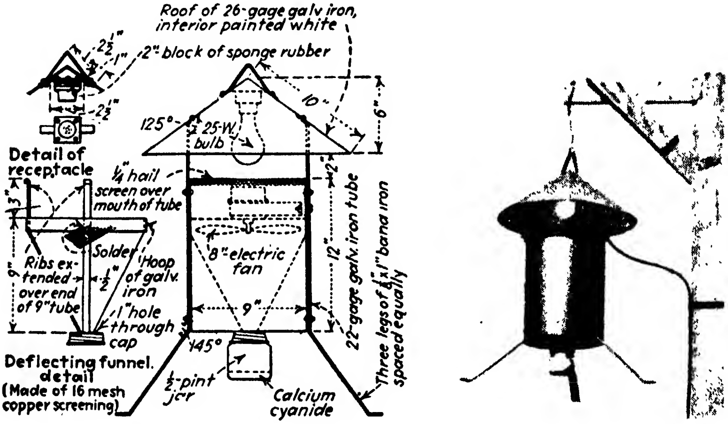


FIG. 5—MOSQUITO TRAP devised by the New Jersey Agricultural Experiment Station workers for survey purposes. At the right is the completed trap as it appears ready for use.

question then arises as to how this information can be secured. In New Jersey, electrically operated mosquito traps have been developed which, over a period of years, have demonstrated their ability to sample the mosquito fauna accurately. These traps are set up at the beginning of the season and automatically, at a predetermined hour every evening, go in operation and continue until the following morning. Each night's catch is then removed and identified. This process continues throughout the entire mosquito breeding season and the results are carefully analyzed.

The number of traps employed depends upon the size of the area, the distribution of the human population in it and the variations in the terrain. Since these are electrically operated devices and because the mosquito pest congregates close to human habitations, the most convenient location for the traps is in the yards of residences. If there are many towns and cities within the area all will have to be carefully spotted with traps and a large

number will be required. If the proposed area includes sections separated by high hills or mountains, it will be necessary to trap the different sections, but always in places where people are living. The greater the number of traps employed the greater will be the accuracy of the survey but fairly satisfactory results may be obtained with only few traps.

It is, of course, advisable at the same time to run a survey of mosquito breeding places, collecting samples of breeding and determining the species concerned. When information from the trap records and from the survey of mosquito breeding places is correlated, it then becomes obvious whether migrants from outside the area form any particular important part of the mosquito fauna in the region under observation. If such should prove to be the case it then becomes necessary to extend the control operations beyond the confines of the proposed area to eliminate the possibility of migrational forms annulling the effect of control work within the area.

Bibliography of Reference Literature

Mosquitoes of North and Central America and the West Indies, by L. O. Howard, H. G. Dyar and F. Knab. 3 vols. Carnegie Institute, Washington, D. C. 1912.

Mosquitoes of the United States, by Harrison G. Dyar. U. S. National Museum Bulletin. Vol. 62, Art. 1, Government Printing Office, Washington, D. C.

Mosquitoes of North America, by Robert Matheson. Published by C. C. Thomas, Springfield, Ill. 1929.

Mosquitoes of New Jersey and Their Control, by Thomas J. Headlee. N. J. Agricultural Experiment Station, Bulletin No. 348. 1921.

Mosquito Eradication, by W. E. Hardenburg. McGraw-Hill Book Co., New York. 1922.

In a long report, an *abstract* is usually included, often at the beginning. Such a summary may vary in its technical character, but it is well to remember that a report is almost always a matter of business. Some readers, such as employers or officials, are mainly interested in the results, rather than the apparatus and technique of experiment, except insofar as these features (dear to the heart of the investigator) are vitally concerned with the outcome. The length of the abstract is subject to the same businesslike demands.

An abstract may also be a useful form in investigation and research. Notes taken in connected summary form will be more coherent than those which give undue attention to details, and more complete than those in topical or even in sentence outline. It is assumed that the

term *abstract*, as used here, means a condensed version of longer material in paragraphs and sentences, like a composition in miniature. Further consideration is given to this indispensable type in the chapter on the research report.

Example: Abstract[1]

BACTERIA IN AIR CONDITIONING

Industrial and Engineering Chemistry

Bacterial control in air conditioning is the subject of a paper by T. S. Carswell, J. A. Doubly, and H. K. Nason in the January, 1937, issue of *Industrial and Engineering Chemistry.* The authors point out that modern air-washing and recirculating systems offer an excellent opportunity for bacterial purification of the air as well as purification in respect to dusts and pollens.

It is frequently assumed, they say, that the water scrubbing to which the air is subjected in the average humidifier will effect the removal of bacteria, as well as dusts, pollens, and molds, with a high degree of efficiency. Actually, however, there is much evidence to the contrary. They therefore report an experimental study made by them, and describe the use of a germicide used in air-washing water, a technique which, they say, has many advantages from the standpoint of cost and convenience.

Most of the common antiseptics, such as chlorine, chloramine, phenol, cresols, and the chlorinated phenols, cannot be used because of the odor imparted to the air. Since the amount of air in contact with the water is relatively enormous, a substance of distinctive odor may seriously taint the air, even though its vapor pressure is quite low. Mercurials and copper salts cannot be used since they are extremely corrosive to the metals which make up the equipment. Ammonium salts and amines cause corrosion of copper and brass parts.

The ideal germicide for bacterial control in air conditioning should be highly toxic to the organisms involved, noncorrosive to the metals usually used in engineering equipment, odorless when used in effective concentration, nonvolatile, nontoxic to man and to higher animals, economical and safe to use, stable even on prolonged aeration, and easily dissolved in water. A commercial mixture of the *o*- and *p*-benzyl phenols meets these requirements and was therefore selected. These benzyl phenols are not only effective in high dilution against many types of bacteria but have the added advantage of being particularly toxic to algae and protozoa, and hence are well adapted to slime control.

[1] From *Mechanical Engineering,* 59: 185–186, March, 1937. Used by permission of *Mechanical Engineering.*

In reporting their conclusions the authors say that the results seem to show that germicides of the benzyl phenol type offer a cheap and convenient way to improve the efficiency of air-washing equipment in respect to bacterial removal. Only the physical measurements of bacterial reduction are reported, and no conclusion as to its possible hygienic significance can be made or inferred. In fact, the industrial application of germicides for the elimination of mold and bacteria from air circulated for process work, such as in bakeries, breweries, and other fermentation industries, offers interesting possibilities entirely independent of the health aspect.

Examination Papers.—Letters and reports form the bulk of professional writing. For the student there is at least one other type, examination papers, which are almost equally important in his pre-professional career. Like letters and reports, examination papers succeed in proportion as they are readable records of the student's knowledge and thinking about a problem. In objective tests, the answers must be accurate; in essay tests, they must also be organized and developed. Coherent paragraphs and logical sentences count, as well as acceptable English and reasonably clean copy. The best of them show marks of belonging to the think-before-you-write class.

EXAMPLE: EXAMINATION ANSWERS (BRIEF)

"Graphs and illustrations are used to give a mental picture of the material to be explained which if put into sentence form would not be so clear or impressive."

"Showing a process or condition which is more familiar to the reader, and which is similar to the one being described, is analogy."

EXAMPLE: EXAMINATION ANSWER (ORGANIZED)[1]

WRITING THE RESEARCH PAPER

I. Selecting a subject
  A. Word limit of paper
  B. Kind of reader
  C. Availability of material
  D. Interest to the writer
II. Locating source material
  A. Library
    1. Card-catalogue index
      a. Under author

[1] Russell B. Terrell, English 412, Ohio State University, Columbus, Ohio, June 10, 1936. Answer in outline form on essentials of a research report. Quoted only in part.

   b. Under subject
   c. Under general field
  2. Encyclopedias
  3. *Reader's Guide to Periodical Literature*
  4. *Agricultural Index* or any other special index
  5. References at the end of chapters dealing with the problem
 B. Professors
  1. Will give more sources
  2. Will give information of their own

III. Taking notes
 A. Take systematically, following outline divisions
 B. Give author, title, and page reference on each note card

OPTIONAL KINDS

Articles.—Papers for technical or popular journals belong in the optional kinds of scientific writing. These appeal to larger groups of readers. Yet technical articles very closely resemble reports. Indeed, they are usually based upon reports. Special consideration must be given, however, to the reader's probable scientific knowledge and his reason for reading. For instance, an article on the purification of a water supply of a city in the professional society journal is for the reader who starts with some knowledge and interest because of his own training and work. An article on this same topic in the newspaper is for the citizen who cannot be expected to have much knowledge upon the topic. The technical man writing for this reader can use knowledge of the technique of journalism advantageously in the general presentation and the selection of details.

College experience in writing technical articles may be had through the student publication of the applied science college. It offers the student writer the same opportunity to address his peers and contemporaries as does the student branch of his professional society, or the student grange. These peers are no mean critics, and there is usually a faculty adviser who has a jealous regard for the reputation of the college. Publication in the student journal, therefore, is a definite sign of writing achievement.

Certain kinds of practical writing, such as *bulletins*, *textbooks*, and *general books*, do not fall within the range of student writing but are very useful for illustrating necessary qualities.

Bulletins.—Considerable material is published free or at low cost by state and federal government agencies. The extension bulletin is

of special interest, because it has to be less technical than the types previously discussed; or rather, the problems, however technical, have to be presented in simple language. Their success depends on their appeal to the average individual—the farmer, the housewife, the mechanic—who wants to improve his skill or increase his returns. Their style is simple and unassuming, but often vivid in a natural way. The writer must have what might be called a practical imagination. He must put himself in the reader's place. His record must be one that the active worker can refer to readily, often in the field or the shop. At the same time, it must be readable enough to grip the attention of men and women who are tired by daily toil, and to pick up the interest again after many interruptions. By example and analogy, by diagrams and word pictures, by directions that are clear as highway signs and suggestions that are as tempting as bargain prices, these results with readers may be accomplished with a remarkable degree of efficiency, as we shall see in later illustrations.

Textbooks.—The textbook of today, in line with general trends in education, is more graphic than that of yesterday. A widely used book in physics[1] contains 789 illustrations in 790 pages—about one to a page—together with hundreds of illustrative examples from the world of baseball, automobiles, flywheels, clocks, sleds, ice, stones, coal, bullets (taken at random from Chapter One).

Such books are in the hands of students in the applied sciences every day. Their chapters or smaller sections, similar in scope to writing assignments of 2000 to 3500 words, provide good specimens for analysis and good models for imitation, provided the difference in purpose is remembered. Even more than reports, they illustrate the essential qualities of precision, clearness, and interest.

General Books.—In addition to textbooks, there is an impressive literature of science for the general reader. Facts, which form the basis for all scientific writing, may be presented with such vividness that they rival fiction. A surprising feature of book selling in recent years is the competition between fiction and nonfiction. The works of Wells, Thompson, De Kruif, Slosson, are well known for their popularization of science. They are wonder books which dramatize the commonplace and simplify the riddles of nature and science. An older master of this art, none the less successful because he was one

[1] SMITH, ALPHEUS W., *The Elements of Physics*, McGraw-Hill Book Company, Inc., New York, 1938.

of the foremost lecturers in his day, was Thomas Huxley, whose essays are still models of exposition.

SELECTION

All writing may be regarded as a process of selection. Those materials and forms are to be chosen which are best suited to the subject and the object, or the problem in hand. If the problem and the form are assigned, as they often are in the world of scientific work, then the person who makes the assignment is responsible, and all that the writer needs to do is stick to it. If the writer chooses his own purpose and form, he is under the same obligation to be consistent.

In the present case, the choices are limited to the kinds of "whole composition" just reviewed, such as letters, reports, abstracts, and articles. These forms, as we have seen, though varying somewhat in the degree of personal tone and in the extent to which they attempt to stimulate the reader, agree in fundamental requisites of precision, clearness, and more variable levels of interest.

If the writer knows his subject and understands his purpose, then his chance of success in writing depends largely on his ability to estimate his reader. Purpose and reader, indeed, can hardly be considered apart. Technical discussion is useful only insofar as it is related to readers' requirements. Throughout the entire preparation of a paper—the definite phrasing of the question which the study will answer, the outline, its expansion into the complete discussion and final copy—the technical writer must have clearly in mind his relation to his readers. If he can foresee, therefore, what they want to know and what will make them want to know more, he will be better able to find the paragraphs, graphic parts, sentences, and words to write a good letter, report, or article.

PROBLEMS

1. Write a letter to your English instructor, indicating your final choice of subject for a report. Give reasons why you chose a particular phase of the subject, and tell briefly what kind of readers you have in mind and what modification of style will be needed for satisfying those readers. A one-page letter is sufficient. Observe the form of a professional letter, including the heading, inside address, salutation, complimentary close, and signature. Follow the model on page 51 for form. Plan the opening and closing statements carefully and develop at least one or two intervening paragraphs. In the final rewriting, try to center the letter on the page.

2. Write a petition to your college dean, asking permission to add an elective course. Give particulars concerning your hours, grades, and reasons why you can carry the extra study load. Indicate where you would place the signatures of professors who endorse your petition. For form, follow the style which is customary in your college office. Make inquiries about the customary form before submitting the petition. If there is no such set style, follow the model on page 53.

3. Write a memorandum to your English instructor regarding material for a report which you have gained through discussion or hope to gain through correspondence. This material will be in addition to that which you are regularly collecting by way of experience, observation and inspection, or research. It may consist of facts or ideas, details or illustrations. Talking over your subject with someone who knows about it, either in person or by letter, is bound to provide new points of view, if not new information. Present your facts or ideas briefly in memorandum form, being certain to specify the sources.

4. Write a friendly letter to someone older or younger than you are. Tell your correspondent about your work or play in college. Try to estimate the reader's interest definitely. Make the letter concrete, varied, familiar, and informal. Do not discuss technicalities unless you are sure they will be understood. Develop the letter by means of description and narration rather than exposition. Do not explain much; present scenes and incidents. Use sentences of varied length, and simple, vivid words. Make the reader see and hear, or become interested through appeals to other senses. Write at least four pages, about 500 words.

5. Write a trial report on your latest laboratory experiment, as if it had been assigned in the research department of a large firm. Imagine that you are a young employee on the technical staff. You have been given an assignment. Your success with the experiment, and especially with the report on it, may mean promotion. Make your report systematic and businesslike. If certain procedures are required in the laboratory work, follow these. Be sure to find out whether a set form is demanded. Write a letter of transmittal to your English instructor, accompanying the laboratory report. In this letter explain the assignment, the form followed, and the importance of the experiment.

6. Select an article in the student engineering, agricultural, or other scientific journal which covers your special field of interest—one, if possible, which is closely related to the subject of your next report. Then find articles on the same subject in a professional magazine and in a general magazine; for example, in *The Engineering News-Record* and in *Popular Science*. In each case, estimate the "audience," or the various classes of student, professional, and general readers to whom the articles would appeal, and analyze the writer's selection of material to meet the reader's needs.

7. Analyze one chapter of a standard scientific textbook. Determine what function it performs in the book as a whole. Within the chapter, determine what portions are most useful for reference, for understanding of the topic, and for arousing your interest. How do the graphic and illustrative features add to interest, clearness, and precision? Does the author make effective use of examples, experiments, comparisons, summaries, historical backgrounds, applications in industry? (Suggested example: "Carbon and Its Oxides," Chap. X, pp. 156–176; McPherson, William, and W. E. Henderson, *A Course in General Chemistry*, 4th ed., Ginn and Company, Boston, 1936.)

8. Analyze a popular bulletin issued by the United States Government, by the Agricultural Extension Department, or by the Engineering Experiment Station of your state. Be sure to select nontechnical treatments. Determine what methods are used by the writer to appeal to the average reader. How is the subject made clear and interesting? What technical matters are left out? How do comparisons, examples, pictures, graphs, tables, summaries, and useful applications help to make the bulletin readable?

9. Write an abstract of a current technical article or of one of your own long reports. Use the model on pages 63–64, trying for simplicity and interest rather than precision. In scope, there is no set rule for reduction, but allowing 100 words to each 500 words of the original will bring fairly good results. Another method is to write one sentence for each original paragraph, making the sentence a summary of the entire paragraph thought, rather than a bare statement of its subject Connect the summary sentences in a sequence.

Chapter Six

Expanding the Outline

MODERN PARAGRAPHING

In the English language, writers began to paragraph effectively about the time that Boyle and Newton were experimenting with gases and gravitation. From the seventeenth century to the twentieth, paragraphs have advanced in step with the natural sciences. If there is any meaning behind this parallel growth, it probably lies in the mutual aid rendered by one activity to the other and in common qualities of exact organization and concrete application. Modern science is noted for its technical thoroughness and widespread useful inventions, for the number of decimal points to which it can measure a temperature, and for the number of homes it can equip with electric refrigerators. Writing has played a part in both of these lines of achievement, while science has taught writers to be more practical.

Whatever may be its relationship to science, modern paragraphing is marked by concrete development and logical organization.

THE VALUE OF TOPIC SENTENCES

Expansion of the outline results in paragraph units of connected sentences, of which the core is a topic sentence. This is a completed statement of the idea implied in a phrase or word outline, or, in the case of the complete sentence outline, the complete sentence. Usually, for a division the items under the Roman numerals and capital letters of an outline furnish these topic sentences for paragraphs. The subtopics, which in turn amplify these items, are the material drawn upon for the development within the paragraph. They are already building up the paragraph to such an extent that they have at times only to be transferred to the expanded discussion and set up in a different arrangement on the page. Of course, it is not a hard and fast rule that only the items of the Roman numerals and the capital letters furnish the topic sentences. At times, these are also found under the

subheadings indicated by lower case letters and Arabic numerals, if the subheadings call for extended discussion. But in any case, three to five words (fifteen to twenty, in the case of the sentence outline) of a topic or a subtopic of an outline become connected sentence groups of 100 to 150 words.

Individual paragraphs are comparable to storage batteries. These are built up individually with the necessary metals and chemicals, and are complete units of power. When necessary, they may function independently; or, arranged and joined together, these separate batteries fit into a general plan and give more power. So paragraphs, complete units of thought for a particular purpose, set up according to the outline specifications and connected, make the completed paper. Full-bodied paragraphs grow from the facts and ideas of the outline. The writer who looks to his outline for specifications will have no need for padding in order to get the required number of words for his long paper. Indeed, he may have to prune and discard.

Example: Outline Expanded into Paragraphs[1]

INKS

By C. E. Waters

ABSTRACT

This circular outlines briefly the history of writing inks, in particular those of the iron gallotannate type, gives formulas for a few of these inks and for three new iron gallate inks, discusses the aging of writing, the restoration of faded writing, and the effect of writing inks upon paper. After this, come brief discussions of several other kinds of inks, including colored writing inks, drawing, stamp-pad, recording, and other kinds. Formulas are given for most of them.

Printing inks and others that depend upon pigments for their color and their special properties are in a class by themselves, and little is said about them in this circular.

The methods of testing given in the Federal specifications for inks are described. Then follows an appendix in which are sections on weights and measures, on equipment for making ink in the home, and on dyes suitable for making inks. Finally, there is given a brief list of selected references.

[1] *Circular of the U. S. Bureau of Standards* C 413, pp. 1, 9–10, Government Printing Office, Washington, D. C., 1936. Used by permission. The introductory abstract and a large part of the table of contents are given, to show the connection of the paragraphs quoted.

CONTENTS

(D) STANDARD FOR GOVERNMENT WRITING INK

The copying and writing ink is of too heavy a body to please most writers, so there is a Federal Specification, TT-I-563, Ink; Writing. It was written originally to provide ink for use in post-office lobbies, where the conditions are devastating to pens. The standard ink of this specification is similar to some of the commercial writing inks. Except for the amounts of dye and preservative (carbolic acid), it is half as concentrated as the copying and record ink. The effectiveness of the preservative depends upon the quantity of it in a given volume of solution, and the ink must contain only enough dye to give a good color to the fresh writing. So the weights of these two ingredients are the same as in the more concentrated ink. The formula for the standard writing ink is:

Standard Writing Ink

	Grams
Tannic acid	11.7
Gallic acid crystals	3.8
Ferrous sulphate crystals	15.0
Hydrochloric acid, "dilute," U.S.P	12.5
Carbolic acid (phenol)	1.0
Dye (C.I. 707; Sch. 539)	3.5

Water to make a volume of 1 liter at 20°C (68°F).

It is hardly necessary to say that the materials for making this ink must be of the same quality as those for making the other standard iron gallotannate inks.

(1) *Concentrated Ink.*—Concentrated ink is accepted if it meets the requirements of the specification for writing ink. The contents of the usual small bottle or the collapsible tube in which the ink is packed will make a quart of writing fluid when mixed with water. Hydrochloric acid is a solution of a gas in water, and it is therefore volatile. For this reason it is probable that most producers of concentrated ink use an equivalent amount of sulphuric acid instead, because for all practical purposes it is nonvolatile.

Concentrated ink occupies less space and weighs less than its equivalent in writing fluid, so the bottle is not so apt to be broken in shipment as a quart bottle of fluid, to say nothing of the saving in express or postal charges. It is also less apt to freeze and burst the bottles than the more dilute writing fluids; while if breakage should occur, surrounding packages will suffer less harm.

(2) *Ink Powders and Tablets.*—Ink powders and tablets represent the last step in concentrating ink. At the time the Federal specification for writing ink was written, and for some years afterwards, the few samples of these kinds of ink that had been examined by the National Bureau of Standards consisted wholly of dyes, or else they were quite unsatisfactory mixtures that purported to make good iron gallotannate inks. It is needless to point out their faults in detail.

The chief problem to be solved in making an ink powder—a tablet is only the compressed powder—is to find a dry acid that will fully take the place of hydrochloric or sulphuric acid. This problem was solved in 1931 by one manufacturer, whose product has been tested numerous times by the Bureau, though never completely analyzed. Since then a chemist of the Bureau has developed two formulas for ink powder, which are given in the next section.

Example: Outline Expanded into Paragraphs[1]

The Outline	Paragraph Development
V. Greenhouse Culture	
A. Importance	
B. Varieties	
C. Culture	*Growing Greenhouse Chrysanthemums*
1. Cuttings	Greenhouse chrysanthemums for the most part are
a. How made	raised from cuttings, taken from the plants of the
b. When made	previous year. The stock plants are potted singly
c. Care	until they begin to grow and shoots appear. A good
	cutting is of three to five inches in length, and is

[1] Balthasar, Harry O., *The Development of Chrysanthemums*, English 412, Ohio State University, Columbus, Ohio, December, 1932. Used by permission of the writer.

taken from the tip of the shoot. It is made at some time between March and June. After the cuttings are made, they are set out in propagating benches until they begin to root. When the roots begin to form, plants should be potted in 2- to 2½-inch pots. From this time on the plants start to grow and the roots to develop; when they have developed sufficiently, they may be benched.

2. Care of plants
   a. Pinching
   b. Disbudding

The primary purpose of raising chrysanthemums is for the production of the flower. In the greenhouse pinching and disbudding are practiced to a great extent to grow desirable flowers, and in return give something to the grower to repay him for his efforts. Greenhouse chrysanthemums have three types of buds, namely "early," "crown," and "terminal." No consideration need be given to the early buds as they will not develop and the plant will continue to grow. The crown buds are accompanied by shoots, and appear early in August.

This type has no commercial use even though it produces the largest flowers. The terminal buds are the last to appear and are identified by being surrounded with a cluster of smaller buds. At least one of these should not be pinched, for no more will be produced. The number saved depends on the size of the flower desired.

3. Fertilization
   a. Kind
   b. Application

It is necessary to fertilize greenhouse chrysanthemums somewhat differently from outdoor plants. In the first place the soil should be a fibrous loam either neutral or acid, and should contain some superphosphate. The phosphate aids in the release of nitrogen in the soil, and proves beneficial. After benching, an application of sulphate of ammonia applied about one pound to every 100 square feet of bench every two weeks, will help the plants. Feeding should be continued until the buds begin to show color; after that time it should be stopped, as an excess of nitrogen will prove detrimental to the keeping qualities of the flowers. Overfeeding is as harmful as underfeeding; therefore, extremes of both types should be avoided.

In the expansion of an outline into a coherent discussion, it will be noted that sometimes the key word of the outline is taken over exactly; sometimes, though implied, it is obvious. If the outline has been precisely and adequately worked out, the task of transforming

these key words to show relationships is a very practical matter and makes for a definiteness and an ease in writing not otherwise possible. It demonstrates convincingly why the outline is really a preliminary, vital to writing, and not a summary, worked up after writing. Of course, a table of contents, a later form, does summarize; but it should be regarded only as a convenient summary of the outline. The relation between the outline for writing and the table of contents for the finished article is well brought out by observing the tables of contents of many scientific pamphlets and monographs. Here the entire detailed outline is often used.

Before beginning the actual writing of the paper, it is well to go over the outline and make a rough estimate of how many words can be allowed to each division that is likely to be a paragraph. This allotment of words to the various paragraphs depends upon the total number specified for the piece of writing. In a 2500-word report, for instance, 150 words might be allocated to introduction, 2000 to the main discussion, and 100 to the conclusion. The paragraph breaks within the 2000-word division are dependent upon the relation of the main topics to one another. The 2000 words would probably make up from six to eight paragraphs, depending upon what parts are extended. With this estimate before him, the student can proceed to write his paragraphs with more understanding and ease than is possible otherwise.

Expository writing, which undertakes to state more fully what is compactly given or implied by the basic laws of science and its procedure, is the form of all scientific writing. Even the description and narration required in technical papers are subdivisions of exposition. In expanding the outline in which have been sorted and selected the relevant topics of a particular report or article, the problem is to find the paragraph development that will most precisely, clearly, and vividly explain a particular group of scientific facts that have been applied with a definite purpose. The particular method of development is suggested by the topic sentence; the unit words will need defining, classifying, itemizing, comparing (or contrasting), explaining.

Limiting requires *definition; i.e.*, statements must be made that give the sense of the words of the topic sentence. This type of paragraph often begins with a logical definition. After the key words are "spotted," they are "unpacked," *i.e.*, defined or expanded by citing

attributes, properties, or relations. The unity, or oneness, of the paragraph has been maintained by the fact that the words to be stressed or explained were a part of the topic sentence, in this case a part of the logical definition. Development has been a matter of synonyms, or amplification of terms. It is usually a limiting paragraph which indicates how terms applicable to the immediate discussion shall be interpreted. The procedure is comparable to that worked out by rule makers for athletic events, who agree upon the rules for a game and determine specifically just what deviations from regular plays, for instance, shall be subject to penalties. A paragraph of definition might, therefore, be considered as the one that sets the rules for the game.

Classification means the arrangement or distribution of facts into groups according to a particular plan. It is a system of arrangement which may result from logical or natural causes. A paragraph discussing the types of equipment necessary to a particular process would probably be developed by sorting and arranging the different pieces in some systematic order. In some laboratory experiments, for instance, under description of apparatus there is a paragraph classifying the testing equipment, and another the material or equipment tested. Though it must include some itemizing, the emphasis is upon a system of arrangement.

Itemization, a listing of details, has several subdivisions:

1. Enumerating, *i.e.*, detailed mentioning of things in succession.
2. Citing examples, *i.e.*, giving the representative cases to illustrate a general rule.
3. Giving particulars, *i.e.*, noting all the details, or the circumstances that make up an incident, or stage of a procedure.

Comparison is a widely used method of paragraph development, because it almost always proceeds from the familiar to the unfamiliar, or from the known to the unknown. Such a paragraph is built up by statements of relative likenesses and unlikenesses. More insight into basic principles of the subject indicated by the topic sentence is required than in itemizing. Analogy is the result of comparison which uncovers inherent resemblances. Contrast also hinges on comparison, with resulting discovery of essential differences. Both comparison and contrast imply actual analysis of the topic to find out these inherent or essential parts or properties of it.

Analysis is also the underlying activity which produces successful *explanation*. By this method of paragraph development, it is possible to show how general laws are applied in particular cases, or, conversely, how the concrete data make it possible to draw general inferences.

It is typical of many good paragraphs that they are both specific and general. In actual practice, most of the methods of development overlap. There are many other devices for expansion, but the student who masters the few mentioned here (now to be illustrated) will be able to do effective work, provided that he checks each topic sentence arising from the outline, to be sure that he has found the best methods in the particular case.

Example: Paragraph of Definition and Contrast[1]

For the purpose of our discussion, defining the term "process industries" would be wise. While this cannot be done very successfully, let us say that the process industries are those in which the physical and, usually, the chemical properties of the processed material undergo marked change. This is in contradistinction to the fabricating industries which are concerned with the shaping, finishing, and other mechanical operations necessary to make a marketable object. This definition is very loose. The manufacture of salt is usually called a process industry, although no chemical change has been made in the salt from start to finish. Steel and iron production, on the other hand, is not usually considered a process industry. It stands on its own feet as a separate entity. The term "process industry," then, is a matter of custom. We say that the production of rayon is a process industry, but the weaving of the rayon thread into cloth is a fabricating or mechanical industry.

Example: Paragraph of Definition[2]

Definition of a Particle.—Any limited portion of matter is known as a *body*. Thus, any particular copper coin is a body. The material, however, from which this copper coin is made is spoken of as a *substance*. When the chemist says the atomic weight of copper is 63, he refers, in general, to the

[1] Boarts, R. M., "The Changing Picture in Southern Process Industries," *Mechanical Engineering*, 59: 173, March, 1937. Used by permission of *Mechanical Engineering*.

[2] From Crew, Henry, and Keith Kuenzi Smith, *Mechanics for Students of Physics and Engineering*, p. 3, New York, 1930. By permission of The Macmillan Company, publishers.

substance, copper, and not to any particular piece of copper. Sometimes a body is so small that its dimensions may be neglected in comparison with other distances involved in the problem. Such a body is called a *particle*, or material point. Thus, for all ordinary purposes, any one of the planets may be considered as a particle in comparison with the distance which separates the planet from the Sun: but for the inhabitants of one of these planets, say the Earth, it is a very considerable body. The emphasis is, as everywhere in physics, upon relative size. The projectile used in a 12-inch rifle is treated as a particle by one who is computing its range; but for the man who is shaping the shot on the lathe, or for the sailor who is loading it upon the ammunition hoist, it is a body of very large size.

Example: Paragraph of Classification[1]

There are three general types of rock drills. They vary widely in size from the comparatively light hand-operated drill to those which require a tripod or column mounting. (1) Sinker drills, which are also called "Pluggers" or "Jackhammers," are used for down hole work; (2) "Drifters" are used largely for horizontal drilling and are normally mounted on a column or tripod; (3) "Stopers" are used for angular or upward drilling.

Example: Paragraph of Comparison and Definition[2]

Electrical Pressure.—In order to cause water to flow in a pipe, it is necessary to have a difference of pressure applied to the two ends of the pipe. This pressure may be obtained by means of water in a standpipe. The weight of the water in the standpipe develops the pressure which causes the water to flow. In order to cause a flow of electricity through a wire, it is necessary to have a difference of electrical pressure between the ends of the wire. This difference of electrical pressure bears the same relation to the flow of electricity that the difference in the hydrostatic pressure bears to the flow of water. In order to obtain a difference in electrical pressure, a number of methods have been adopted. The oldest and most familiar for small currents is the use of a battery. The technical term for a difference of electrical pressure is *difference of potential*. A dynamo, battery, or other source capable of maintaining a difference of potential is said to have an electromotive force.

[1] Taylor, G. R., "Rock Drill Lubrication in Mines," *Canadian Mining Journal*, 57: 589, November, 1936. Used by permission of *Canadian Mining Journal*.

[2] Smith Alpheus W., *The Elements of Physics*, 4th ed., p. 374, McGraw-Hill Book Company, Inc., New York, 1938. Used by permission of the author and the publishers.

Example: Paragraph of Itemization[1]

The great *abundance of recorded information* makes chemical literature searches difficult. Modern chemistry is only a little over a century old but its literature is truly voluminous. And it is growing at an accelerated rate. One reason for the great magnitude of the literature of chemistry is the fact that there are many active chemists. The American Chemical Society, for example, is the largest scientific society in the world. It has about 14,000 members. But a reason which is perhaps still more influential (in a sense only a different point of view) is the broad scope of chemistry. Chemistry is a fundamental science; it plays a part in many other branches of science and is a factor in many industries. In recent years the work of the physicist, involving as it does so frequently such subjects as atomic structure, radioactivity, gaseous ionization, crystal structure, spectroscopy, and electron theory, has more often than not been of distinct chemical interest. Much of the literature of biology, medicine, engineering, agriculture, and the like is of a chemical nature. Such important industries as those dealing with the production or treatment of metals, foods, fertilizers, fermentation products, pharmaceutical preparations, ceramic ware, refractories, cement, gas, and other coal products, petroleum, paper, explosives, dyes, paints and varnishes, fats and oils, soaps, sugar, starch, leather and rubber, as well as the many inorganic and organic chemicals, have their trade journals and other literature of real chemical value. Many municipal problems, such as water and sewage treatment, are chemical problems, and there are numerous publications for this field. The number of periodicals which a present-day chemical abstract journal must cover systematically to be complete runs over 1200. The number of abstracts published by *Chemical Abstracts* in 1926 totaled 29,202. When one considers these facts it is difficult to avoid a "swamped" feeling unless he knows pretty thoroughly how to select and use the parts of the literature which may be needed.

Example: Paragraph of Explanation[2]

The Second Law of Thermodynamics.—*Energy is indestructible.* This is the first law of thermodynamics. However, energy tends to appear in ever less and less useful forms. This is the law of the *degradation of energy*, the second law of thermodynamics. The potential energy of the pile driver is quickly

[1] Crane, E. J., and Austin M. Patterson, *A Guide to the Literature of Chemistry*, p. 7, John Wiley & Sons, Inc., New York, 1927. Reprinted by permission of the authors and the publishers.

[2] Eldridge, John A., *The Physical Basis of Things*, p. 75, McGraw-Hill Book Company, Inc., New York, 1934. Reprinted by permission of the author and the publishers.

turned into kinetic energy and this in a moment is dissipated in heat as the blow is struck. The chemical energy of the gasoline-air mixture is converted intc intense heat and pressure, drives the automobile, and, if we choose, will ultimately appear as warming of the brakes. Such processes cannot be reversed; by using the heat in the brakes we cannot make gasoline from the exhaust gases. All existence consists of energy changing from one form to another and nearly always this is a one-way progression of events. This is the second law.

PARAGRAPHS AND ORGANIZATION

Paragraph division, in general governed by the principle of unity, is indicated on the written page by indention and occasional side headings. By this typographical means, which separates one phase of a topic from the others, precision and clearness are aided. Though completeness requires some full-bodied paragraphs, length is not in itself a logical determiner of separation. To make the facts more visible and accessible, there is, however, a tendency toward shortening paragraph length. A one-sentence paragraph is sometimes used for emphasis. But the overuse of either the short, which ceases in time to have emphasis, or the excessively long, which repels the reader, should be avoided. Variety in paragraph length, as well as in paragraph form, maintains interest.

The internal *arrangement* within paragraphs is likely to be logical when needs of precision and clearness dominate, as they usually do. The effect of logical sequence, whereby one fact or idea seems to grow out of another, is good. Some simpler methods of organization are those of time, space, and enumeration.

Connection.—The coherence of paragraphs, whether external or internal, is founded on logical arrangement and pointed up by smooth transitions. Scientific writers use more linking phrases than those who aim for rapid movement. These connecting parts resemble the ramps in the baseball park or highway overpass. For example see page 81.

PARAGRAPHING FOR INTEREST

Interest is the quality which makes a reader like to read. Clearness, which makes it easy for him to read, may therefore be regarded as transitional, between precision and interest. The most important function of clearness is that of saving the reader's energy, an idea made famous by Herbert Spencer. It removes difficulties which set up

resistance. Another source of resistance is monotony. Variety provides relief and so makes reading easy. Yet variety, perhaps the greatest resource of interest, carries us beyond mere prevention of resistance into positive, powerful stimulation.

Variety.—Paragraph development offers much opportunity for variety because there selection has the greatest range. Besides the

EXAMPLE: PARAGRAPH DIVISION, ARRANGEMENT, AND CONNECTION[1]

The Connections	The Paragraphs
The five laws	*The Meaning of Laws in Science.* The five laws
just considered	just considered are merely general statements
	in regard to the conduct of gases *as determined*
laws,	*by experiment.* Like all other scientific laws,
they	they offer no explanation of the facts which
they state	they state, nor do they place any restriction
	upon nature which compel obedience, as the
They	laws of a country bind society. They are
statements	simply concise statements of what might be
	called the *habits of nature* as observed in
experiment	experiment.
Now	*Forming a Theory.* Now that we have found it
state concise (laws)	possible to state in concise form (laws) the
	conduct of gases under varying conditions of
questions	temperature and pressure, many questions
Why gases	arise in our minds. Why do all gases expand
	and contract in the same way, regardless of
Why	their other widely differing properties? Why
gas How	does heating a gas cause it to expand? How
gas	does a gas exert pressure?
answer these questions	To answer these questions we begin by a process
imagine	of *imagining.* We imagine that the similar
gases	conduct of all gases is probably due to some
	simple mechanical structure which they all
	share, and we try to form a mental picture of
mental	this structure. *The process of constructing a mental*
picture of this kind theory	*picture of this kind is called forming a theory.*
picture	Having constructed a picture which would
answer questions next	answer all our questions, we next set about
experimental	securing experimental evidence which will
theory	show whether or not our theory really cor-
	responds with the facts.

[1] McPHERSON, WILLIAM, and W. E. HENDERSON, *A Course in General Chemistry,* Fourth Edition, pp. 71–72, Ginn and Company, Boston, 1933. Used by permission of the authors and the publishers.

great number of different ways for amplifying topics, the paragraphs may be made up in a great many combinations. Sometimes even a single paragraph will contain several types of development.

Division, arrangement, and even connection may also be varied.

In division, the size may range through the average of 100 to 300 words to the extremes of a sentence or a page. Splitting paragraphs down to sentence length is a favorite device of modern popular and journalistic writers. It is evident that such a rhythm when overused will soon sound rat-a-tat-tat. How much better equipped is the writer who can use all sizes.

In arrangement, variety may be prepared for, even in the outline stage. Such "psychological" planning can be continued with the copy. On page 5 or 10, let us suppose, the reader will be tired. It will do no harm to introduce a little diversion in the form of incident or vivid description. Variety helps the reader along over hard roads. A well-known text in general chemistry starts with a historical introduction, followed by modern chemical problems; it discusses matter and energy, and then oxygen; the states of matter, and then carbon. This alternation between general and specific topics, elements and common combinations, theories and things, moves ahead in a spiral, rather than a rigid straight-line direction.

Connections may best be varied by avoiding persistent use of formal transitions like *however*, *this*, *thirdly*, *our next topic will be*, etc., and trimming sentence ends, both of them, so that they fit and join. Even repetition, one of the best linking devices, may be made to work for variety by reiteration through synonyms rather than identical words, and by changed positions within the sentence.

Emphasis.—The main function of emphasis is to attract or recall attention, though it also helps clearness. The methods by which certain points may be made to stand out and attract more attention than others are expansion, reiteration, focus, and terminal position.

A paragraph which is longer than the neighboring ones will naturally be noticed more. An idea repeated in the same paragraph or a later one will be more strongly impressed on the memory of the reader. Emphasis by reiteration, like that of expansion, does not conflict with variety if the restatement is synonymous.

A paragraph which is unusually short in contrast to others will attract attention. The effect is due to isolation and focus, and also to the fact that the contents are brought nearer than usual to terminal

positions, especially in single-sentence paragraphs. The beginning and ending of a paragraph are favorable for extra notice. It is a good thing to use these points for important parts. At the same time, if the details in the inner region are likely to be buried and forgotten, it may also be advisable to build up their claim to interest by expansion and reiteration.

In general, emphasis by focus and terminal position will not interfere with variety unless used to excess. Overemphasis defeats its own purpose. If we accent everything, we accent nothing. Some relief and contrast are needed. Some parts must be unobtrusive, and there is a chance that they will be noticed by contrast, as a quiet, distinct voice is pleasing in the midst of shouts.

In addition to variety and emphasis, the skillful *suggestion of values* is a powerful and legitimate way of winning the reader's interest. Values resulting from applied sciences are both practical and stimulating; they are beneficial in the broad sense of the word, which includes culture and human betterment, as well as satisfaction of the crudest wants. The modern world of invention has not only made life more convenient, but has provided interesting fields of activity for those who like to deal with tangible things. Airplanes are, thus, not only a benefit to all who ride in them but also to all who design, build, and repair them. The keen interest of the present-day reading public is shown by the vast amount of magazine matter printed on scientific subjects.

No one, not even the most exact technician, need fear that his scientific accuracy will be distorted by the introduction in the right place of a few details which show how vital his work is and what a game it is to pit the imagination of man against the inert or resistant powers of nature. In any case, reports addressed to employers and clients, or articles addressed to the general public will command better attention if they indicate practical results.

Example: Paragraph Illustrating Interest[1]

SWIFT STRIKING FURY

None of the many exhibitions of Nature's destructive forces is so terrifying nor so nearly irresistible by the works of man as the tornado, and the one which struck northern Mississippi, Alabama and Georgia early this week

[1] Editorial, *Engineering News-Record*, 116: 540, Apr. 9, 1936. Used by permission of *Engineering News-Record*.

ran true to form. Its path, as in the Illinois storm of 1925 and the St. Louis storm of 1927, was strewn with indiscriminate crushing, tearing apart and overthrowing of all manner of buildings and structures. Unlike the hurricane and the flood, the tornado gives little warning of its approach and its forces are largely unknown in magnitude or character. As a result the cyclone-cellar complex of the early settlers has been perpetuated and engineers and laymen alike too often take a fatalistic view of any efforts to cope directly with tornado forces. The pioneer study of damage made by the Western Society of Engineers following the Illinois storm indicated that there are types of construction that will at least minimize damage, such as firm anchorage of building to foundation, effective ties between walls, roofs and floors, and the use of partitions as bracing diaphragms instead of as just room enclosures. For brick buildings, a substantial foundation, a wall laid up in cement mortar and reinforced with pilasters, and well-anchored floors and roof have proved to be effective. Every tornado's wreckage is a monument to poor construction, and there is no reason to believe that the debris of Tupelo, Anderson and Gainesville will be any exception. It should, nevertheless, be immediately examined by engineers. Only in this way will our knowledge of tornado effects be strengthened and our ability to resist the swift-striking fury of such storms be increased.

PARAGRAPH GROUPS OR SEQUENCES

According to function, paragraphs may be designated as introductory, body, and concluding. These divisions, obviously, make for appropriate grouping of individual paragraphs, though both introductory and concluding are often single units. Much depends upon the length of the discussion, the complexity of the subject, the reader, and the purpose of the whole discussion. In the development of the paragraph unit, a recognition of its function is helpful in giving the right direction to the method of expanding the topics of the outline. This, in a way, is determined at the time the writer estimates the approximate number of words that he is going to need for each section. For instance, terms often must be understood at the outset of a discussion if the succeeding amplification in the body is to mean anything. Again, the particular discussion must be placed in relation to any that has been previously presented upon the same subject. This is often indicated as the history, and frequently results in citing concrete details of other studies.

In general, the main topics of the outline determine the grouping of paragraphs; indeed, they are often labeled with identical or

equivalent headings. It is to be noted, however, that *Introduction* and *Conclusion*, special paragraph groups, are not always indicated by their form names, either in the outline or in the copy. Concrete headings, like *History* or *Summary*, which suggest the contents, are preferable to blank headings, *i.e.*, topics like *Introduction* and *Conclusion*.

Introduction.—Definite, effective beginnings are characteristic of scientific writing. The anticipated reader of the scientific article influences the introduction very markedly. For the general reader, a vivid beginning that will catch the attention is required. For the reader with scientific knowledge and interest, attention can be expected, though even here an introduction that will suggest new dimensions to familiar things is always helpful. Though the beginnings may vary to arouse the reader, as well as tell him what the report or article is about, they do not tend to be lengthy and elaborate. In practical communication, the introduction is not meant to be like a palatial waiting room, but more like a simple, sufficient doorway or hallway to the subject. In professional reports, directness often goes so far as to follow the principle of journalism in headlines and leads, and announces at once the conclusions and recommendations, or summarizes the results as well as states the topic. The busy executive wants to know without extensive reading what action the expert suggests. Indeed, the first heading of a professional engineering report is "Brief summary", which often includes object, results, conclusions, and recommendations.

A prime requisite of any introduction is precise and clear statement of the subject and object of the article or the report. This same function is shown in good letters. In reports, and especially in articles, there may also be a legitimate attempt to get the reader interested. In scientific writing, which deals with difficult and serious problems, probably the best way of stimulating readers is to show the use and value of the subject. Brief historical surveys may get attention, as well as clear the way for understanding. Striking illustrations are good if they do not result in false leads which leave the reader out on a limb. Another danger lies in excessive length, which makes for a top-heavy effect.

Still, an introduction may be both vital (showing use and value) and vivid (appealing to the senses) without being indirect, irrelevant, or longwinded. No definite size can be specified. One page in ten, or a hundred words in a thousand, will make fair proportions.

EXAMPLE: INTRODUCTION[1]

WATCH FOR CAR NO. 20

The driver of every 20th car in this country will be in an accident resulting in the death or injury of a man, woman, or child this year, if automobile accidents continue at their present rate. Every motorist may be thankful if he is not riding in Car No. 20.

Year after year the terrific toll of motor vehicle accidents in the United States has been increasing. In one year about 36,000 people died because of someone's recklessness or carelessness, and more than 1,000,000 were injured—many crippled for life.

To enable the thoughtful motorist to improve his skill and check his driving practices, some of the basic principles of better driving are presented in this booklet.

Body.—The body of a report or article (the same is true concerning the less expanded paragraphs in a letter) is made up of several paragraph groups or sequences which develop the statement set forth in the object and for which the way has been cleared in the introduction by definition, by history, by stating point of view. The number of these body paragraph groups corresponds with the needs of the problem. In building up a satisfactory outline, the number and the type have been predicted when the outline has been prepared. Precision requires that the division and arrangement be logical. Clearness does not conflict with these demands; but common sense and experience testify to the overwhelming advantage of comprehensive groups, and the futility of excessive subdivision.

In a report of 2500 words, if we allow 250 for introduction and 250 for conclusion, the remaining 2000 will permit of five general *divisions* or paragraph groups, averaging three paragraphs each; but unless peculiar conditions make it necessary, ten main heads would be too many. The dangers of overdivision are that the reader finds it hard to remember and becomes confused with classification puzzles so that he cannot give proper attention to the facts. Where the material logically requires a great deal of subdivision, it may be well to place it in tables rather than paragraphs.

Paragraph groups, like paragraphs, have their organization problems of division, arrangement, and connection. The first two of

[1] *Calling All Drivers: A Guide to Better Motoring*, p. 1, Metropolitan Life Insurance Company, New York. Used by permission of the company.

these are largely solved by the outline. It may be well to check to see whether the main headings can be improved and whether some variation may be introduced which will satisfy a reader's needs without loss to the strength of the original plan. Outlining is both logical and psychological, yet it is not always possible to anticipate all the reader's wants when blazing the first trail into the subject. In regard to connection, also, the center and side headings will help.

The chief problem that remains is that of providing clear and varied transitions. These have been illustrated in the previous section on paragraph organization. Another device which is available when dealing with the larger sequences is that of whole paragraphs, usually short ones, often consisting of single sentences, which are directive rather than developing in their function.

EXAMPLE: DIRECTIVE PARAGRAPHS; INTRODUCTORY AND SUMMARY[1]

[Introductory]

Crude oil is transported primarily through pipelines which weave their way through deserts, swamps, rivers, cities, and mountains to refining centers, in some cases for distances of 1500 miles. Even gasoline finds its way through pipelines to consuming centers over 1000 miles from where it was refined.

[Summary]

The vast network of pipelines in the United States includes not only those gathering oil from the well to field storage tanks, and trunk lines to transport it to refining centers, but also the maze of refinery pipelines and those that carry gasoline to cities, as well as the pipelines which convey crude oil and refined products through the water to tank steamers plying the seven seas.

EXAMPLE: DIRECTIVE PARAGRAPHS; INTRODUCTORY[2]

[Introductory]

There are a great many familiar synthetic materials that owe their existence to careful applications of solvent reactions. A brief consideration of the things already done will point the way to the things yet to be done.

[1] EGLOFF, GUSTAV, *Earth Oil*, Chap. VII, Oil Transportation, pp. 104, 115, Williams & Wilkins Company, Baltimore, 1933. Reprinted by permission of the author and the publishers.

[2] FURNAS, C. C., *The Next Hundred Years: The Unfinished Business of Science*, Chap. XIII, Outdoing Nature, p. 159, Reynal & Hitchcock, copyright, Williams & Wilkins Company, New York, 1936. The previous chapters in Part II, "Chemistry," are on Synthetics and Solvents. The extract is reprinted by permission of Reynal and Hitchcock, Inc.

Mother Nature did rather poorly in the matter of plastics. Long ago the knowing chemists decided that what this country needed was a good plastic material, one that could be easily molded at low temperatures and then would solidify quickly and forever after hold its shape. It should be of pleasing appearance, should resist corrosion, abrasion, solvents, and heat, and should be strong. Preferably it should be inexpensive. Such a material does not grow on trees. It has never been found in the ground. It might be found in a magician's hat but is more likely to be found in the chemist's test tube.

Conclusion.—The concise answer to the problem set forth in the introduction must be precise and clear. A conclusion may also involve a summary. Its end position is favorable for a clinching restatement. For reference and research, the reader will naturally look there for the "conclusions and recommendations," unless he has already come upon them in the introduction. Even then, they may be in both places. Recommendations, concise interpretation of the conclusions, suggest a course for future or continued action; they go beyond bare summarizing but they are logically implied by the previous discussion.

Variety is possible through reiteration in different words. A final suggestion of use and value will not be out of place. Most scientific writers shy away from euphuistic or flowery style in the conclusion and everywhere else. Still, it may be possible to stimulate the reader by means of realistic and vivid language to reread the report or article, to go on investigating the subject, or to be on the watch for future developments. As an empty formality, the conclusion has little value, yet a short statement showing that the end has been reached and preventing the impression of abrupt breakoff does no harm.

Example: Conclusion[1]

SUMMARY

We may classify dinnerware as follows:

(1) *Earthenware*, a porous nontranslucent ware with a soft glaze.

(2) *China*, a commercially vitrified translucent ware with a soft glaze which resists scratching to a greater or less degree.

[1] Watts, Arthur, S., "The Selection of Dinnerware for the Home," *Engineering Experiment Station, Circular* No. 21, pp. 14–55, Ohio State University, Columbus, Ohio, November, 1932. Used by permission.

(3) *Porcelain,* a thoroughly vitrified, translucent ware with a hard glaze which resists scratching to the maximum degree.

No dinnerware possesses all the merits and none of the faults and the purchaser must accept some compromise. The ware with the best resistance to scratching has less brilliancy of surface. The most durable decorations are most limited in color range. The ware which stands the greatest mechanical abuse lacks the high translucency and daintiness of the art chinas and porcelains. Before you buy dinnerware, decide whether you want ware that will resist scratching or ware with the most durable decorations; whether you want ware which is vitreous or whether the porous body with a good glazed surface will meet your needs.

Under reasonable conditions such as prevail in the average household, any of the wares and any of the decorations described will give acceptable service, and the purchaser is left to decide what type of ware and what type of decoration are desired.

The type of ware, the class of decoration, and the amount and grade of labor employed are the controlling factors in the cost of dinnerware.

All types of dinnerware are obtainable in all grades and the cost of the ware is no indication of its service qualities.

In selecting dinnerware for the home use the same consideration for quality and value that you exercise in buying other articles. Do not buy dinnerware for the name on the bottom. Buy it for appearance and for service qualities. If the name on the ware stands for guaranteed quality, it is worthy of consideration. Otherwise it is merely a form of advertising. Remember that as attractive and as serviceable dinnerware is manufactured in the United States as is produced anywhere in the world, and that much of it is made in Ohio.

SUMMARY: FROM OUTLINE TO PARAGRAPHS

The best scientific writing is marked by well-organized movement. This "march of ideas," as it has been called, is made possible through the expansion of the static outline into paragraphs. Paragraphs are made up of sentences in logical sequence. Sequence is also evident in paragraph groups, with the single paragraphs as units. With these larger units, we can see the organizing function, which begins with the outline, being carried out more noticeably. In other words, paragraphs and, to a much larger extent, paragraph groups are units of control as well as of development. They keep the parts in place and thus prevent interference with the forward movement of facts and ideas.

Without paragraphs and paragraph groups, which are clearly indicated on the page by indentions and headings, the main ideas would be buried in subordinate details. Organized movement would be lost. In older days, when paragraphs were too short and sentences too long, much of the prose was extremely difficult to read. Modern paragraphing, from the seventeenth to the twentieth centuries, has brought about a welcome change. This improvement, which, as we have seen, took place exactly in the same period as the growth of modern science, was due mainly to better unity, coherence, and emphasis in the paragraphs.

In the present chapter, the needs of unity, coherence, and emphasis have been presented in terms of the practical organization problems arising from them. These are development, division, arrangement, and connection. In all of these the first requirement is precision, which is closely related to standard practice and usage. Without sacrificing this ideal of complete, exact, and relevant records (the truth, the whole truth, and nothing but the truth), the writer usually is required to take a further step, and in consideration of the special or general "audience," to make his presentation as clear as possible. The ability to do so demands imagination. For those with a somewhat greater gift of imagination there is the final possibility of interesting the reader, through paragraphs which are sufficiently varied, emphatic, and suggestive of genuine values, to make up a readable report or article.

Problems

1. Take one of the outlines prepared for Chapter Four, and write up the paragraph development of one main topic after the manner of the first example in this chapter, but with topic sentences added. The main topics will be indicated either by Roman numerals or by capital letters (I, II, III, or *A*, *B*, *C*). Incorporate the subtopics by repeating or expanding the key phrases. Follow the order of subtopics exactly. Write at least 100 to 150 words to the paragraph. First compose topic sentences for each paragraph needed.

2. Write a *limiting* paragraph on some simple but definite topic such as ball bearings, phosporus, carburetor, triple play, electric washer, airplane propeller. Define the term by giving its general class, such as machine or machine part, chemical element, sport event, household appliance, and the like. Then state the peculiar characteristics which differentiate the thing defined from others in the same class, such as roller bearings, arsenic, spark

plugs, putout, electric wringer, aileron. Expand briefly by citing properties, uses, and standard requirements. Before writing, compose a topic sentence. Follow the models on "Process Industries" and "The Particle."

3. Write one or more *classifying* paragraphs on topics like colloidal states of matter, levers, carbon and its oxides, roadbed soils, garden soils, automobile accessories, testing apparatus for an experiment, materials to be tested in an experiment. Arrange the material in standard form in one or more paragraphs, as needs require. Define and compare briefly, to show that the general grouping and the divisions are justified. Use side headings, or underline key words. Before writing the paragraphs, compose topic sentences for each one. Follow the model on "Drills."

4. Write at least one *itemizing* paragraph on some such topic as: standard equipment for surveying, standard equipment for soil testing, wear and tear on tires, off flavors of milk, finishing concrete, complete lubrication of a car, landing at an airport. Specify, list, and particularize. Give all the things needed, all the typical cases, and all the essential steps in the stage of a process. If necessary, use more than one paragraph. Compose topic sentences for all paragraphs, before developing them. Follow the model on "Chemical Literature."

5. Write a paragraph of *comparison* on some topic like baseball and softball, hot water and steam heat, gas and electric refrigerators, center and side traffic lights, rural and urban mail delivery, federal and state experiment stations, intercollegiate and intramural athletics. Analyze the problem, to see whether likeness or unlikeness predominates; and stress comparison or contrast accordingly. Opinions as to superiority may be expressed, but they are not necessary. State the facts impartially. Include a little definition, classification, and itemization wherever the fundamental purpose will be helped by these other methods of development. Expand to two or more paragraphs if you think proper. Write topic sentences before developing the paragraphs. Follow the model on "Electrical Pressure."

6. Write one paragraph with the main objective of complete precision, perfect accuracy, and exactness. Write another on the same phase of the subject with the ideal of unmistakable clearness in mind. Reduce all technicalities to familiar things by explanation, comparison, and restatement in simpler terms. Finally, on the same restricted topic write another paragraph, in which you aim entirely at interest. Use vivid language; suggest uses and values; present pictures and tell stories; make description and narration predominate. For each of these, write a topic sentence beforehand. When you have finished the three paragraphs, either combine them in shorter form, one or at most two paragraphs; or mingle the elements of precision, clearness, and interest in some varied or useful way. For example, you might begin with a vivid part, follow this up with a related detail of high precision to be immediately clarified in simple words. Make

the road to the more difficult portion inviting and easy. Suggested topics are: laminated plastics, Diesel engines, television, the combine (harvester and thresher), air conditioning, airplane instrument panels, methods of home insulation, public address systems.

7. Write a short introduction for a long report, in which you state the purpose of the write-up, the use and value of the investigation or experience on which it is based. The subject should be taken from your own interests. Follow the model on "Calling All Drivers."

8. Write a short conclusion for a long report, in which you summarize the matter in the form of definite conclusions, with or without recommendations, and with or without some glimpse into the future of the problem which will stimulate the reader to recall or even reread the report. Draw the subject from your own experience, observation, investigation, or reading. Follow the model on "Dinnerware."

(The following exercises are for oral discussion)

9. Examine the introductions of several standard scientific textbooks. Decide how the writer succeeds in making clear his subject and object, and in interesting the reader. Study the opening paragraphs of several chapters in the same texts for similar illustrations of method.

10. Examine the introductory parts of several scientific bulletins issued by federal or state experiment stations. Determine how statement of the subject and object, suggestion of value and use to the reader, and possible prestatement of conclusions are handled. Estimate the space given in proportion to the length of the entire report.

11. Study conclusions in books, and especially in reports and bulletins, in the same manner as in Problems 9 and 10. Look for summaries, recommendations, and appeals to reader's interest.

12. Examine the paragraphing problems in a single page of any standard scientific textbook. Determine, with reference to pages before and after if necessary, the methods of paragraph division, paragraph arrangement, paragraph connection, and paragraph development. Under division note the average and varying length in number of words, as well as logical reasons for separation of parts. Under arrangement, observe whether time, place, logical sequence, or climax determines the order. Under connection, note the use of center or side headings, and of transitional sentences or phrases. Note also whether general prestatements giving the gist of several parts to follow, or general restatements giving the gist of several parts which came before, are used. Under development, look for limiting, classifying, itemizing, comparing, and other methods.

Chapter Seven

Figures and Tables

ILLUSTRATION

Examples within the field of a subject and analogies or comparisons which draw upon other fields more familiar to the reader have a power of turning the light on things which he wishes to understand. This method is called illustration. A common meaning of this word, according to the dictionary and familiar usage, includes pictures also. Pictures visualize facts, ideas, and values with more speed, better focus, and better frames than paragraphs. The eyes of the reader see the point all at once, all together, and all by itself.

This optical advantage, though limited to effects of line and space, with occasional color and texture, is undeniably pleasing to readers of the printed page. In fact, print as well as pictures may be handled as an optical problem by the print-shop compositor. In this chapter, which deals with tables as well as figures (graphs, drawings, etc.), the student will find it interesting to think of the printer's point of view and, within the limits of progressive draft writing, to try "composing," *i.e.*, placing and spacing the graphic parts in a good fit with the paragraph parts.

At the same time, the writer's primary object at this stage, expanding the outline, is still present. Mass development in scientific writing makes considerable use of figures and tables. These parts, at least the more graphic of them, are sometimes called a "language."[1] The suggestion is indeed a vivid one; but in this book on English the figures and tables will not be considered as language parts, needed for detail development, but mainly as special elements of about the same size and uses as the paragraph parts (including paragraph groups) needed for mass development. Strictly speaking,

[1] FRENCH, THOMAS E., *A Manual of Engineering Drawing for Students and Draftsmen*, p. 1, McGraw-Hill Book Company, Inc., New York, 5th ed., 1935. See also Chapter XX, pp. 387–400, "Charts, Graphs, and Diagrams."

tables are not graphic, yet their line and space arrangements mark them off from continuous text. Like pictures, they are framed with more white space, *i.e.*, margins, than are paragraphs.

Figures are generally listed separately from tables in the prefatory pages (front matter) next to the Table of Contents page. Longer tables, and sometimes all of them, as well as complicated graphs, may be placed in appendix position (with the reference matter). In the progressive stage of writing, we are concerned mainly with the graphic parts which must be fitted into the text.

TABLES

The transition from paragraphs to figures may be seen at its earliest stage in informal *column matter*. Like outline topics, quotations, and formulas, this is indented more than is plain paragraph matter. Thus, although it is entirely lacking in the picture aspect of graphs, pictorial diagrams, or photographs, it begins to show something of their "frame." The function is usually itemization, with some possibility of classification. The columns are merely lists of things, generally introduced by a sentence. The phrasing of the item is in topics rather than sentences.

Example: Column Matter[1]

Substances which kill the insect by actually coming in contact with its outer covering are spoken of as contact poisons. How they effect the killing is not always well understood; but it is doubtless accomplished in a variety of ways, ranging from genuine caustic action to internal poisoning through penetration of the tracheal tubes. Following is a list of contact poisons in order of their value and importance:

lime sulphur
kerosene emulsion
lubricating oil emulsion
miscible oils
tar oil distillates
nicotine
pyrethrum

In the case of *tables*, the advance toward graphic characteristics is a little more marked. The matter is not yet pictorial, but it has more

[1] Clime, Chester A., *Economic Status of Insects*, English 412, Ohio State University, Columbus, Ohio, December, 1932. Used by permission of the writer.

"frame." Not only extra spacing but ruled lines, horizontal and in many cases vertical, mark it off clearly from the page and the plain paragraph matter. The interior parts are also set off by the ruled lines, so that the question of placing becomes important. Each item must be in the proper box.

The development is itemizing, classifying, comparing, or contrasting. It may be introduced by a sentence or, as is more often the case, headed by a label. As in the case of column matter, the details are in language form, in words or phrases, symbols or formulas, rather than points, lines, and contours.

For all practical purposes, there are two kinds of tables: those which amplify the subject and those which simplify it. The former kinds belong in the appendix. They are made up of evidence which is essential but so detailed that the gist of it can be presented more compactly in paragraphs of the text. The simpler kinds are what interest us here. Summarizing the facts in visible, accessible, and symmetrical form, they are an asset to the printed page. They are there for reading and not merely for record.

Example: Table[1]

A great many samples of all kinds of rocks have been collected and chemically analyzed, so that we may confidently say something about the average composition of the outer part of the lithosphere. Tables have been prepared of the ultimate composition of the lithosphere in terms of the percentages of the elements present. When we look at such a table, we find to our surprise that out of the ninety-two elements, only eight are present to the extent of 1 per cent or more.

Element	Percentage
Oxygen	46.46
Silicon	27.61
Aluminum	8.07
Iron	5.06
Calcium	3.64
Sodium	2.75
Potassium	2.58
Magnesium	2.07
	98.24

[1] Croneis, Carey, and Wm. C. Krumbein, *Down to Earth: An Introduction to Geology*, p. 18, University of Chicago Press, Chicago, 1936. Used by permission of Professor Croneis and the publishers.

Let us look here at the part of such a table that includes the eight most abundant elements. An outstanding feature of this table is that oxygen is by far the most abundant element of all. We do not mean to say that the oxygen exists in its free state. Obviously, it is chemically bound up in the rocks. Similarly with the seven other elements; not one of them occurs in its elemental state in the rocks; all of them are combined in one way or another into chemical compounds.

EXAMPLE: TABLE[1]

SOLUBILITY OF GASES IN 100 CUBIC CENTIMETERS OF WATER

Names of gas	*Amount dissolved at 0° and under 760 mm. pressure*	
	Grams	*Cubic centimeters*
Ammonia	100.1192	129,890.00
Hydrogen chloride	82.9738	50,600.00
Sulfur dioxide	23.3513	7,979.00
Hydrogen sulfide	0.6726	437.00
Carbon dioxide	0.3386	171.30
Oxygen	0.0070	4.96
Nitrogen	0.0029	2.33
Hydrogen	0.0002	2.14

GRAPHS

The items in a table may be presented with sharper focus in a graph or graphic chart. This more pictorial form is especially well suited for comparisons, in two or three dimensions. The explanation of trilinear, logarithmic, and nomographic charts lies beyond the scope of this book. Still, it is possible to overestimate the difficulty of both graphic construction and graphic analysis.[2] The underlying mathematical theory is fascinating but an understanding of it is not necessary for practical results. A graph is a true picture of the under-

[1] McPHERSON, WILLIAM, and W. E. HENDERSON, *A Course in General Chemistry*, p. 228, Ginn and Company, Boston, 1933. Used by permission of the authors and the publishers.

[2] *Graphs, How to Make and Use Them*, by Herbert Arkin and Raymond R. Colton, Harper & Brothers, New York, 1936, deals with these problems in a simple manner.

lying theory. Concrete lines and "curves" take the place of dry data and abstract equations.

On the other hand, the student is not advised to adopt the extreme methods of some advertisers. Volumes, except in the circular or pie-diagram form, are more subject to error and to optical illusion than are linear measures. Standards of accuracy have been set up through the cooperation of engineering societies. These standard rules will be found in textbooks on engineering drawing and in the standard works on graphic presentation.

EXAMPLE: GRAPH[1]

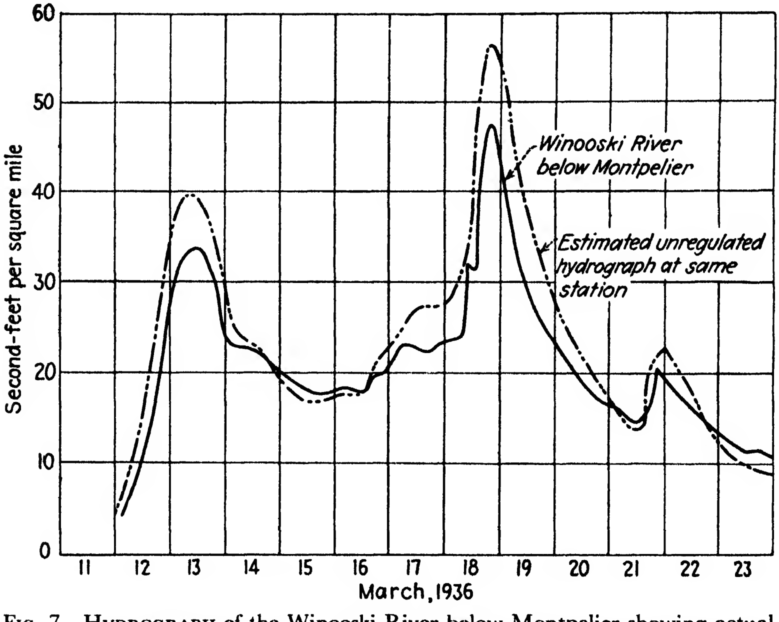


FIG. 7—HYDROGRAPH of the Winooski River below Montpelier showing actual runoff and the estimated runoff had the river been unregulated.

Fig. 7 shows estimated hydrograph on the Winooski below Montpelier, had the East Barre and Wrightsville reservoirs not been constructed, and the actual flood hydrograph at the same point with these reservoirs functioning. As the unregulated hydrograph is based on inflow hydrographs to the two

[1] CURRAN, CHARLES D., "Spring Floods Test Winooski Flood-control System," *Engineering News-Record.* 117: 513, Oct. 8, 1936. Used by permission of *Engineering News-Record.*

dams and on an estimated rate of flood travel, the peaks shown may be much less than what would have occurred had the flow been unregulated.

DIAGRAMS

With diagrams, we are getting farther and farther away from language, even mathematical language, and into the expression medium

EXAMPLE: DIAGRAMS[1]

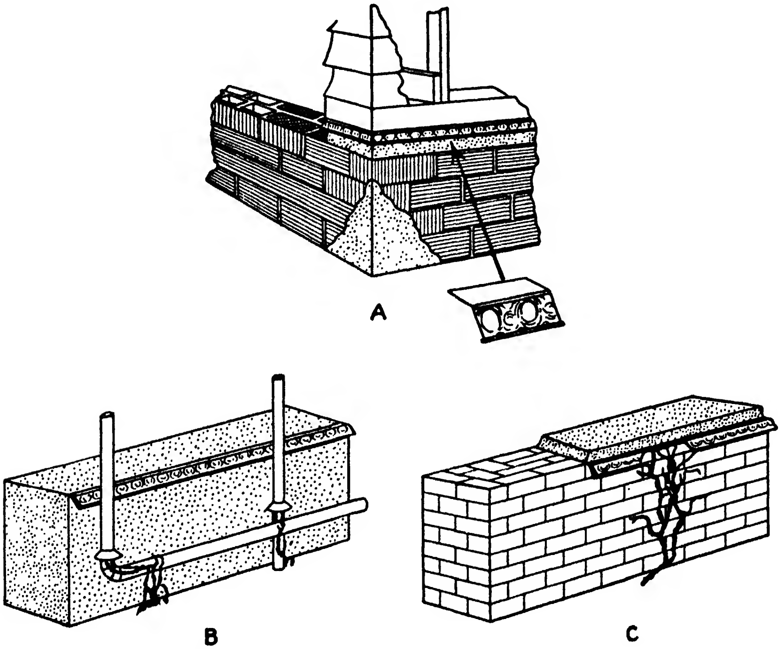


FIG. 5.—How to insulate foundation units against termites:

A. Foundation wall of hollow tile surfaced with stucco, showing metal termite shield in place. Notice how the top of the wall is capped with sheet slate and concrete.

B. Concrete wall with termite shield at top, the horizontally laid piping fitted above bend with metal shield to shut off termite tubes. The vertical pipe also has a termite shield.

C. Brick wall fitted with termite shield and capped with concrete. Notice how the shield mechanically blocks the earthlike shelter tubes of the termites.

[1] PARKS, T. H., "Control of Termites in Buildings," *Bulletin of the Agricultural Extension Service, The Ohio State University*, No. 143, p. 6, November, 1935. (Example clear without context.) Used by permission.

of drawing. The distinction between freehand drawing and engineering, or mechanical, drawing is difficult to define. Some very fine artistic work has been done in the field of botanical and architectural illustration, both by professional workers and by students. At the present moment we are concerned with simpler problems, such as shop layouts, flow sheets, apparatus, and handy inventions. Maps are special types of diagrams which figure prominently in the writings of modern experts on flood control, soil erosion, conservation, natural resources, and many similar problems.

PHOTOGRAPHS

With the photograph, we reach the extreme of pictorial illustration for scientific writing. With or without color, it represents a complete divorce from the paragraph method of describing details of observation. Except for the labels identifying it, a photograph speaks for itself without any use of language, though sometimes legends are written below the picture to explain details. The value of camera pictures for general interest is very high, as is shown by the frequency with which they occur in modern magazines, both technical and nontechnical. In addition to arousing and holding interest, photographs may also add greatly to the precision and clearness qualities of an article or report, especially when they are supplemented by sufficient explanation in the paragraphs.

Example: Photograph[1]

MACHINING WORLD'S LARGEST BEARING (see page 100)

Believed to be the largest journal bearing ever made, the 317,000-pound horseshoe bearing which will carry the million-pound load of the world's largest telescope at Mt. Palomar, California, is shown being machined.

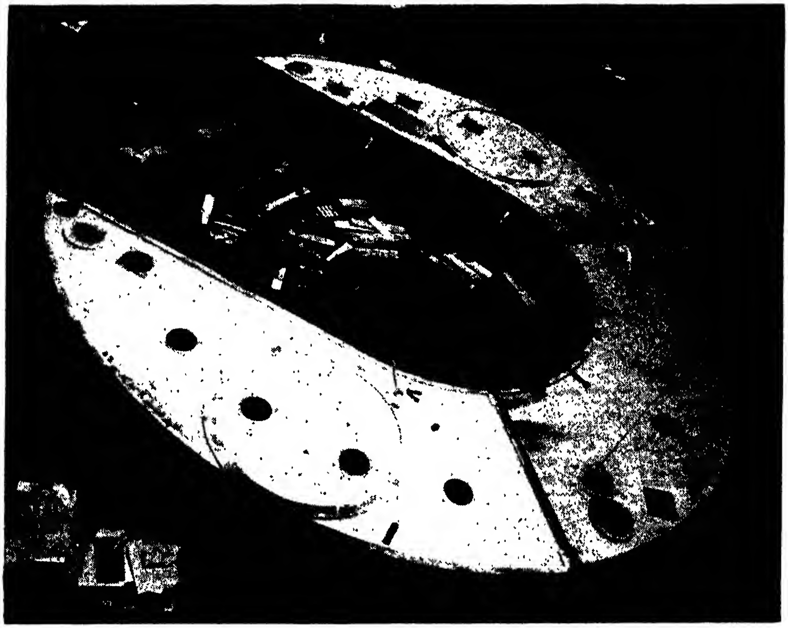
During machining the horseshoe is bent out of shape while its surface is machined so that it will be squeezed back into an arc of a circle under the weight of the telescope mounting. The bearing is 46 feet across and 53 inches thick. Because of its unusual size, it had to be made in three sections so that it could be shipped on flat cars.

The work of pulling and pushing the hollow steel frame out of its circular line is done before it is turned on a specially constructed boring mill. Near the bottom of the "U" a large compression member pushes outward while the top of the bearing is pulled in by steel bolts with turn buckles.

[1] *Engineering News-Record.* 120: 319, Mar. 3, 1938. Used by permission of *Engineering News-Record.*

When hoisted into position on a steel base at the telescope site, the bearing will rest on two steel oil pads through which oil will be pumped at a pressure of 250 pounds per square inch.

Designers of the telescope support selected the horseshoe shape bearing to enable the 60-foot telescope tube, housing the 200-inch reflecting mirror, to swing easily between the sides of the horseshoe for an unobstructed view from the polar to the southern horizons. The ability of the bearing to turn



freely on its oil pads will permit the tube to be sighted from the eastern to the western horizons.

The telescope tube, a welded steel box structure, will swing between two 60-foot steel tubular arms forming a yoke. The upper end of the yoke will be welded to the horseshoe and a flat swivel at the lower end will turn on a ball and socket bearing floating on oil. The yoke will be hung equatorially parallel to the earth's axis, or at an angle of slightly more than 33 degrees which is the latitude at Mt. Palomar.

ORGANIZATION AND THE GRAPHIC PARTS

After the writer has selected the figures and tables for his report or article, he has to fit them in. Here the problem, as in the case of

paragraphing, resolves itself into questions of division, arrangement, and connection. More specifically, the tables, graphs, diagrams, and photographs are to be placed, spaced, and labeled. Inspection of the article on "Mosquito Control" in Chapter V will show how different types of graphic matter can be coordinated with the text.

The *division* of graphs, diagrams, photographs, drawings, and tables, or their separation from the text, is made clear by liberal margins. When the graphic part is the width of the page text, only the upper and lower spaces need be left. When the figure is not so wide, either the entire remaining white space is left open, or when the figure is "cut in," enough left and right margin allowance is made for clear separation. Another distinguishing feature is the fact that there is usually more internal space in the graphic parts.

Two other possibilities of division are the appendix method and the plate method. Long tables and very complicated graphs and diagrams are often better in the appendixes, along with "reference matter." Good pictures, simple diagrams, and compact tables, however, are too interesting and helpful to be relegated to the trailer.

In printing, a full-page illustration or group of illustrations which is to be on different paper and an isolated page is called a plate. Plates may come in the frontispiece or between two pages of the text. Hence, student writers, who are required to follow standard manuscript practice in submitting copy on one side of the page, often place their illustrations on the back of the page opposite the related discussion (or in the frontispiece). This practice is legitimate for student reports or matter that is not to be printed.

Problems of *arrangement* are external and internal. The picture or table must first of all be placed in a position where its meaning in relation to the text will be clear. The order of items within the element follows standard practice or logic. For example, the standard arrangement of a graph is from left to right. Maps and architectural plans are placed according to points of the compass. Other diagrams and drawings attempt to follow natural, common-sense arrangements.

In tables, the extreme left position generally houses the specific item and the extreme right the significant results, such as averages, percentages, etc. The vertical order may be from small to large, or large to small; from less significant to more, or the reverse. In some tables, however, the emphasis of end positions, either horizontal or

vertical, is not needed, the general arrangement being that of common sense or mere enumeration.

Figures are formally *connected* with the text by arabic numerals and legends below; tables, by roman numerals and headings above. Both legends and headings are compact and well centered, but the bottom position is more favorable to explanation. Hence, definitions of terms and acknowledgments of sources are usually given below the graphic part, just beneath it.

This tendency toward self-sufficiency does not debar further explanation in the accompanying paragraphs. Teamwork between the graphic parts and the ordinary continuous copy is a good thing to try for.

Sources.—Student writers are urged to make their own graphs, diagrams, photographs, and tables, but it is legitimate to borrow them, with proper acknowledgment. Where no publication is intended, acknowledgment is enough. For articles in student journals, however, the practice of writing to the authors and publishers for permission to use graphic parts must be followed.

GRAPHIC REQUIREMENTS

The language items included in graphic parts, it may be noted in passing, present some difficulties in grammar (especially use of the parallel construction), punctuation, and mechanics. The student is referred to Chapters Two and Eight for requirements of *good English* and to Chapters Two and Nine for requirements of *clean copy*. For the present, the standard requisites of precision and clearness must be remembered in relation to mass, or general development.

In regard to precision, the student in the applied sciences, who is already familiar with this quality in laboratory work and reading, is urged to carry the habit over into his reports. For advanced problems, the manuals and models in his own special field will help him more than an English textbook can presume to do.[1]

In general, the graphic parts should be complete, exact, and relevant. In particular, these subrequirements of precision overlap with those of clearness.

[1] In the particular matters of form, as they are handled by printers, it may be well also to consult a *Manual of Style* (*i.e.*, printing style) like that of the Chicago University Press or the United States Government Printing Office.

All craftsmen (and most applied scientists are craftsmen of very high skill and training) like to speak their own language. This is undeniably their right when they are communicating with fellow specialists. In other situations, however, they may be addressing not only general readers but also those whose knowledge lies in another field. The entomologist does not speak the same dialect as the breeder. The electrical engineer is master of symbols that read like Egyptian inscriptions to the ceramics expert.

Not only technical terms but graphs, diagrams, and often tables, need explanation. Lines and spaces will focus and frame a pictorial element, but labels, captions, legends, and accompanying discussion in the text are needed to show what they are, what they are for, and what part they play in the entire report or article.

INTEREST IN GRAPHIC PARTS

Graphic parts relieve and recreate the eyesight. They are powerful resources of variety, emphasis, and illustration of values. These values may be aesthetic as well as practical. The element of design enters in. Even a photograph, a machine-made picture, may be more or less effective and expressive as more or less care has gone into the selection of it for intrinsic interest and for its use in the text. Sometimes, the application is general rather than particular. Students who are too fond of pasting in pictures may have to restrain themselves, to prevent a report from turning out to be a scrapbook.

The artistic possibilities of scientific writing will be readily understood by the student in architecture or engineering drawing. For those in other curriculums, especially agriculture, it may not be out of place to suggest that underneath all art lies nature. A photograph of spring corn, or a field to be rotated with various crops, will never be uninteresting if it is well taken and well fitted into the report.

ILLUSTRATIONS BUILT IN

In modern scientific writing, the figures and tables, at least those in the text of scientific works, seem to be built-in parts of the structure rather than attached and detachable gadgets. In actual practice, it is better to build them up before building them in. The room which they need and the work which they have to do cannot be definitely determined until they are fairly complete. Even the next-to-last draft is too late for major changes, except at the cost of considerable labor.

Time will be saved by having the graphic parts prepared before attempting the paragraphs.

Most students in the applied sciences will find it interesting to begin writing a report with photographs of concrete things, and they are accustomed in many courses to start off with columns of specific data. When these are assembled and organized according to the outline, some paragraph ideas are bound to suggest themselves.

Problems

1. Count the illustrations in a modern scientific textbook. Include all small figures which are not numbered or listed with the figures. Draw conclusions as to the proportion of graphic parts which can be effectively used, in relation to the number of pages. Consider which pictures are used for interest rather than information which is absolutely necessary.

2. Examine and report your findings orally on the placing of tables in the text or appendix of a textbook, technical report, or bulletin. Bulletins may be of the popular type, such as publications of the United States Government and the extension departments of your own university, or the state university in your state.

3. Write a short paper in which the starting point is a photograph, a diagram, and/or a freehand drawing. Suggested subjects are: views of the apparatus in your next laboratory experiment, or of part of the equipment in your home workshop; a "picture" of a crystal lattice or of the layout of a laboratory, an athletic field, an airport, a crop-rotation plan; a line-drawing of a leaf, a cornice, or an airplane wing. Supplement with explanation as in 1. Follow the models on "Termites," "Machining World's Largest Bearing," or (see Chapter Five) "Mosquito Control."

4. Write a paragraph or a sequence of paragraphs explaining the arrangement of parts of a machine, the setup of apparatus in an experiment, the layout of a garden or a modern stock farm. Add a diagram with the parts lettered, either following the explanation or inserted in a place suitable to the sequence of the discussion and the balance of the page.

5. Review the outline for your next long report and insert at proper points among the subtopic matter, in parentheses: graph, diagram, photograph, drawing, and table of contents.

(The following problems, though they seem to imply considerable training in drawing or mathematics, are intended to show possibilities of correlating work in various basic subjects and of using graphic matter as a starting point for writing.)

6. Write a short paper in which the starting point is a graph. Use a simple two-dimensional type; for example, the relation between speed in miles per hour and the consumption of gasoline in an automobile; or the relation

between boiling points and barometric pressure; or the variation in market prices of chickens, tomatoes, or coal, from month to month or year to year. Label the horizontal and the vertical axis for the respective dimensions which they represent. Write or print a short legend under the figure. Leave space for the cut to be inserted on a page, either to occupy the entire width (well spaced), or to be partly surrounded by text. Write at least one paragraph of explanation, for general readers who do not understand much of the technical problems involved. As to form, follow the model on the "Winooski River."

7. Follow the procedure in Problem 6, this time with a table of data. Now the tabular matter will be indicated by a heading (caption) above, rather than a legend beneath. Observe standard practice in use of ruled lines for columns and rows, provided the material does not consist of very few items, in which case spacing should be more liberal. Place the table on the page to cover the entire width, and write at least one sentence of introductory statement. Follow the table with explanation for a general reader. Suggested subjects are: fuel consumption and costs for electric and gas refrigeration; moisture content of soils at various depths; constituents of bituminous (or anthracite) coal; athletic records made by representatives of your own college compared with intercollegiate and other amateur records. As to form, follow the models on "Lithosphere" and "Gases."

8. Make separate lists of figures and tables for your next long report on experience, observation, or research. Arrange them on separate pages, if they will not fit symmetrically on one page. Use Arabic numerals for the figures and Roman numerals for the tables.

9. Write an appendix for your next long report, consisting of a table too long for the text or a mathematical formula too complicated to be explained in the text. Typical examples might be: complete data of several months' observation on use of gasoline in a new automobile; the formula for the catenary as applied in a suspension bridge.

10. Assemble a simple, unruled table or column of two types of related data; present the same material in a simple graph; and follow up with a paragraph of explanation.

Chapter Eight

Language

TECHNICAL AND NONTECHNICAL LANGUAGE

Modern scientific writers make considerable use, not only of graphs and diagrams, but also of symbols, such as Arabic and Roman numerals (10, X), and letters from the Roman and Greek alphabets (x, Φ). These symbols may be combined into formulas and equations, like CO, carbon monoxide, and

$$Fe + S \rightarrow FeS,$$

the union of iron and sulphur forms iron sulphide.

Symbols and symbol groups are very compact technical substitutes for words and word groups. Yet, even the words for which the symbols stand are generally technical, as unknown quantity, mathematical function, iron sulphide. Technical words are not so compact as symbols, but they share the same high degree of precision. Most of them are so exact that they have no synonyms; *i.e.*, they cannot be replaced by other words with meanings practically equivalent. They are standard. Perhaps it is more correct to say that they have been standardized, through the general agreement of scientists and their societies and through the persistent efforts of these men to keep the terms uniform.

The present chapter deals with both technical and nontechnical language. As in the case of graphic elements, the student should turn to technical authorities for guidance on technical terminology. For the use of nontechnical language, and for the elementary problems of sentence structure and word choice, he should consult the dictionary and the English handbook. The present discussion is by no means intended as a handy substitute for these indispensable works of reference. It is rather an effort to show what the most vital problems are and how they are related to the work of students in the applied sciences. The principal problems are those of precision,

clearness, and interest. Technical terms represent one solution of the precision problem. Nontechnical language is also capable of being highly precise, but it is perhaps more useful in securing clearness and interest.

PRECISION

The foremost requisite (or should we call it a prerequisite?) of scientific writing is precision. This quality is shown not only by close thinking on the subject in hand but also by correct and careful usage. The best scientific writers are accurate in form as well as meaning. They take pains to avoid fragment sentences, dangling participles, and expressions like "this data." Among them, standard language, like standard procedure in the laboratory, seems to be taken for granted.

Usage is nothing more or less than custom. It is not a matter of morals, mathematics, or even good taste, which, according to one of the oldest proverbs, varies with the individual. Like other standards, such as the foot, gram, or watt, usage in language is handed down from one generation to another, used by the leaders in the field, agreed upon, imitated as a model, and to prevent friction, more or less regulated. Of course, in some details of usage there is variation. The British spell *labor* as *labour*. Such variations are not vital. Consistency only is required. In this chapter, the discussion will be concerned with usage in relation to precise meaning. Although usage is a matter of agreement in the practice of effective writers rather than a matter of logic, some cases are affected by logical needs. For example, the expression, "We didn't find no traces of arsenic" is poor logic, and in any kind of writing which aims to be precise, it is substandard usage. Those groups of writers and speakers who determine and maintain by agreement what is standard in language concur in what is logical usage, as well as that which has little to do with logic.

Usage is tested by specific cases. For example, it is substandard to say, "The machine runs good"; but not, to say, "The machine looks good." In the first case, the adverb *well* is needed to describe how the machine runs, or how the verb acts. In the second case the adjective *good* is needed to describe, not how the machine goes through the process of running, but how the machine, as a subject of the statement, appears to be. Not only grammatical problems but also confusions of meaning in words like *accept* and *except*, *affect* and *effect*, are

fully illustrated and explained in the handbook. The dictionary takes care of some technical terms like *adsorb* and *absorb;* for the suffixes or end-parts of words which have a definite meaning in chemistry, as *-ite* and *-ate*, one may have to consult more special books.

Precise Sentence Construction.—One of the greatest needs in scientific writing is for exact statements. These must be made in complete sentences, sometimes in complicated ones. Complicated sentences can be understood through analysis of the simple but complete form which underlies all of them. If we omit interrogative, imperative, and exclamatory statements, and limit the discussion to simple declarative types, we see that the latter always follow one of two formulas. These are[1]

S, subject: V, verb: P, predicate complement
Clay is sticky
S, subject: V, verb: O, object.
Water dissolves sugar

Strictly speaking, we may also have S V, as in "Ice melts." This shorter form usually has modifiers, as in "Ice melts quickly in hot weather"—S V Mv Mv (modifiers of verb). Then too the S V O is open to expansion, as in "Sleet made the roads slippery" or "The firm made Mr. Smith manager." These may be represented as S V O P. In this case the P following O is always different from the P following V. To avoid confusion, however, the second form may be written as S V O O; and a similar formula may be used for any sentence having two consecutive objects.

Usually, the arrangement is in the order given above.

The difference between the S V P and S V O constructions is interesting. It has been found significant in the modern mathematical logic. A predicate complement, P, in spite of its predicate position, is always closely connected with the subject. Sometimes it is an equivalent of the subject. An object, however, is not the same thing as the subject except in cases like "The machine righted itself," where the subject is obviously acting upon itself. Generally the verb in

[1] The student who finds the S V P O M C symbols strange may use the more familiar grammatical terms, such as noun, pronoun, verb, adjective, adverb, conjunction, and preposition. In connection with these, however, the S, V, P, and O are strongly recommended for help in detecting basic elements of sentence structure.

the S V O form shows relation of an active kind between two different things.

The student of chemistry may find an analogy with properties and chemical conduct suggestive. The S V P statement says that a certain thing is characterized by certain properties, and the S V O statement says that a certain thing acts in a certain way toward another thing, (occasionally itself). This difference still holds, even when the predicate complement, P, is a noun, as in "Clay is an earthy material."

If we compare "The doctor shaved himself" with "The doctor operated upon himself," we notice that the word *himself* has similar form and function in both statements. The formulas are S V O and S V C O, with C standing for *connectives* of any kind. As a matter of fact, many verbs have to be supplemented by another word of the connective type in order to be followed by an object. Connectives are of two main types: prepositions and conjunctions. In the S V C O construction and also in the very common C O combinations found in other positions, as *on the hill* in "The house on the hill was sold" or "Let me live in a house on a hill," the prepositional connective, or the one that takes an object, is necessary. Conjunctive connectives do not take objects. Some of them join words of parallel grammatical rank, as in "The curves and grades (S C S) were dangerous."

In the last example the word *the* is a *modifier*, M. Modifiers may be put down as modifying a subject, Ms; an object, Mo; a predicate complement, Mp; a verb, Mv; a modifier, Mm. Examples are: "The road was slippery," Ms S V P; "Avoid the dirt road," V Mo Mo O (Note that *dirt* though like a noun in form is a modifier in function); "The concrete was badly cracked" and "The road was a state highway," Ms S V Mp P and Ms S V Mp Mp P; "The machine skidded dangerously," Ms S V Mv; "He works very slowly," S V Mm Mv.

To save trouble, all modifiers may be listed as M. They play a large part in the expansions of the basic sentence structure, especially through phrases. Phrases may be analyzed, word for word, with the symbols already given, S V O P C M; but the problem is greatly simplified by regarding phrases in the light of their function, and using the same symbols with the word "phrase" added. Thus, the very simple statement "Clay is sticky," S V P, may be qualified by an Ms, *red;* an Ms phrase *found in certain parts of the United States;* an Mp,

too; and an Mp phrase, *to handle easily*. The simple basic sentence amplified would read: "Red *clay* found in certain sections of the United States *is* often too *sticky* to handle easily." If the scientific writer is having trouble with a long statement, he will find it helpful to check for the basic sentence.

To answer needs of detailed and complicated relationship, basic statements may be expanded by incorporating other related sentences within the original sentence. These sentences, already closely united or blended with the incorporating sentence, are designated as clauses. If they retain, in the resulting sentence, their original identity, they are considered independent clauses and the resulting sentence is called *compound*. If the clauses brought in lose their rank, *i.e.*, play a subordinate part as embedded sentences functioning as subject, predicate element, object, or modifier, they are considered dependent, and the resulting sentence is *complex*.

The following is an example of a compound sentence:

> The surface water supplies are the first to feel the effects of drought, *and* they are the first to feel the relief afforded by rains.

Originally, this might have been two simple sentences:

> The surface water supplies are the first to feel the effects of drought. They are the first to feel the relief afforded by rain.

These were felt, obviously, to have connection rather than separation. As a result of this feeling, they were tied together by the connective *and*, which indicates the equality of the parts; yet they have individual identity, suggested by the insertion of the comma.

The following example of the complex sentence gives evidence of subordination of a clause which, as a result, has no independence when it is taken out:

> Alkaline reaction of the soil often produces flowers which turn "blue" and fade and droop quickly.

As simple sentences this might read:

> Alkaline reaction of the soil often produces flowers. They turn "blue" and fade and droop quickly.

But this arrangement makes too much separation, for flowers need description to identify the results of alkaline reaction of the soil; consequently, while *they turn "blue" and fade and droop quickly* is a com-

plete simple sentence grammatically, it means little, since the reader does not know the reason for what happens. When embedded, however, in the first sentence, *Aklaline reactions of the soil often produce flowers,* as a restrictive clause describing flowers, it is indispensable. The relative pronoun *which* indicates its subordinate relation. If *which* is used as the substitute for flowers, the sentence cannot stand alone, even though it has a subject and a verb. It is only a modifier in the whole statement, the simplified formula for which is S V O Mo clause.

Before we proceed further with the discussion of the subordinate elements, it will be well to have some definite understanding of the phrase. For general use, the phrase may be considered as a fragment of a sentence with some individual identity but without the means of going under its own power. For instance, the fender of an automobile is a unified fragment, but it functions only when attached to the body of the machine. Under no conditions could it have activity by itself. It can never be put in a form whereby it can proceed under its own power. So the phrase, though it has form, can never go forward on its own. It lacks the power word, the verb—that word which expresses some action, occurrence, or state of being of the subject. It is a small portion attached to the basic elements of the sentence.

The difference between a phrase and a clause, however, is less useful in this discussion than a clear understanding of subordinate elements which make for precise adjustments and close-knit relationships. A subordinate element in a sentence substitutes for a part of speech. Practically speaking, the parts of speech are words that function as subjects, verbs, predicate complements, or objects in the basic S V P, or S V O structure, or as their modifiers and connectives which are secondary to this bare framework of a sentence. Phrases may take the place of any element just listed, S V P O and of M (modifier) and C (connective); in complete sentence forms, they always have a subordinate relation. Clauses are subordinate only when they act as substitutes for subjects, predicate complements, objects, and modifiers. As modifiers, they may limit verbs, nouns, adjectives, adverbs, as well as subjects, objects, predicate complements, and even other modifiers.

Note in the following examples the varied uses of the subordinate clause:

> *That the river would soon overflow its bank* became increasingly evident. [S clause V P.]

Here the clause substitutes for the noun as the subject of the sentence.

> They will not come *until it stops raining.* [S V Mv clause.]

Until it stops raining modifies the verb come, and substitutes for an adverb.

> Detroit, *which originally was settled by the French,* is as American as baseball and automobiles. [S Ms clause V P.]

Which originally was settled by the French, modifying the noun *Detroit,* substitutes for an adjective.

A little analysis of these subordinate clauses will help the student who is having difficulty with fragment sentences. All of them might occur as sentence fragments, even though they have S V P or S V O structure. Their connectives clearly show, however, that their function is that of a sentence part, not a sentence whole. While scientific writing makes occasional use of fragment sentences in positions where they will be clearly understood, such use is rare. They do not add to precision; indeed, they run the risk of subtracting from it. The rule, followed with few exceptions, in professional practice, is: *Make all sentences complete with S V, S V P, or S V O constructions which are not subordinate.* Phrases cannot make up a complete sentence because they are all subordinate.

Thorough understanding of this rule requires more grammatical knowledge than can be given in this book. The connectives are the best clues of relationship, both in clauses and phrases. Certain ones like *until, that, which,* are always used with subordinate clauses; and *to, in, with* belong usually with phrases. For complete lists of the conjunctions, see the Handbook. Other clause connectives, such as *and, but; hence, however,* never introduce subordinate clauses but are clear indicators of independent clauses. For example:

> Clean and regular cultivation will often help keep the plants healthy, but almost invariably a few pests will still bother us.

(Basically S V O, C S V O.)

Punctuation is also a clue, if good models are followed. There is a difference between punctuation which is clear in a general way and that which is exact and unmistakable. With some variations, the

period is the sign of a complete sentence; the semicolon, of an independent clause without connective; the comma, of an independent clause with a conjunction, and of a dependent clause or phrase which is nonrestrictive. A nonrestrictive element is one which is not necessary to the meaning and which can be removed without making the rest of the sentence meaningless. For example, note the *which* clause in

> Detroit, which was originally settled by the French, is as American as baseball and automobiles.

When the *which* clause is left out, what is left makes sense.

> Detroit is as American as baseball and automobiles.

But note the following example:

> Baseball players who represent Detroit are called Tigers.

The omission of the clause *who represent Detroit* would leave the statement misleading or meaningless.

Punctuation, as here illustrated, is evidence of accurate thinking. Precise punctuation is a part also of exact knowledge of sentence structure. A student who would not think of leaving out the subscript 2 in CO_2, because its omission means the difference between a lively ingredient of gingerale and the fumes which have laid so many victims dead in garages, should be able to distinguish between the comma and the semicolon. By itself, the comma usually indicates subordinate sentence parts; the semicolon, independent clauses.

The college student should not overlook the value of a definite conception of the basic principles and nomenclature of grammar—that logical analysis of the classes of words, inflections, relations indicating orderly arrangement and functions. He should at least take a few sentences apart to find out what makes them "go." Just as he may take apart a piece of mechanism to see the arrangement and the motive power, so the alert writer can improve his writing by taking apart sentences; then by reassembling the integral parts he may become aware of the procedure required to develop the finished sentence. In this service work on sentences, there are two sources of trouble which should be checked: (1) misrelated modifiers, and (2) misplaced modifiers. Of course, these are not the only causes of loose-jointed, bungling style, but they are the common ones.

The rule for the position of modifiers is commonsense itself. *Place the modifiers as close as possible to the parts which they limit or qualify.* Difficulty arises in the case of those modifiers which seem to relate to the whole idea rather than to the verb or some other part. The placing of the word *only* is an example. Most people do not misunderstand the common expression:

I only go down town once a week.

Still, in careful writing it pays to put *only* where it logically belongs, for example:

Water evaporates only at certain temperatures.

The rule for close position, however, has some latitude. Phrases and clauses which are too long to be inserted in the middle of a statement without slowing it up are sometimes placed before, sometimes after, the statement in which they modify the verb or perhaps the whole idea. When principal phrase and clause modifiers are meshed, no change in the position of any of them could be made without loss of precision.

EXAMPLE: PRECISION IN SENTENCE CONSTRUCTION[1]

SPECIAL SOIL CONDITIONS: MARSHES, PEAT BOGS, ETC.

Besides the ordinary difficulties from oversaturated soils such as excessive plasticity, excessive movement from the shrinkage and swelling of the soil, and its failure to support loads when in the plastic condition, the road builder must meet the problems of stabilizing marshes, marl pits, deep peat bogs, and muck holes. This is especially true in territory that has been glaciated as a large part of the north central states has been.

Each marsh, peat bog, or muck hole is a separate problem. In some the peat has drainage to some extent, and here it is more compacted and resistant to displacement than when found in a deep non-drainable peat hole.

In other cases the peat has been mixed with black organic-filled soil and water so that a black liquid muck is formed that has little or no consistency.

In many cases the pot hole will have a rich black soil top of two to four feet in thickness, then two to four feet of brown peat followed by from 10 to

[1] ENO, F. H., "Some Effects of Soil, Water, and Climate upon the Construction, Life, and Maintenance of Highways," *Bulletin of the Engineering Experiment Station, The Ohio State University*, No. 85, Investigation in Cooperation with the Ohio Department of Highways, p. 61, November, 1934. Used by permission.

30 feet of a grayish blue clay of about the consistency of paste. This rests usually upon a plastic blue clay which becomes quite hard and stable within a few feet. Occasionally the gray paste rests directly upon a thin gravel layer which in turn rests upon a hard-pan of blue clay.

The road engineer who has not been trained in glacial geology is quite often deceived by the surface appearance of the ground on which he is preparing to build a road. It looks like a fine black soil with excellent bearing power, which it really does have; often, however, soundings through the good soil show that it is actually floating on the aforesaid gray paste.

Words.—Words, the raw material for any written presentation of facts, feelings, and thoughts, have many applications and are assembled to make many designs and structures. The words that make up the vocabulary of the scientific writer have two levels of precision—technical and nontechnical.

Technical words are more precise because they are controlled. Conferences of experts are needed to keep them under control. They are assigned as exact identifiers, and as such they have to be learned by the student along with the things which they identify. For these narrowly circumscribed technical words, special dictionaries are available; and the modern unabridged dictionaries, especially in recent editions, contain many technical terms. Further information can be secured from technical literature and from spoken use by experts.

A certain class of technical terms belongs to speech more than to writing. The shops and factories, mines and quarries, farms and forests, even the walls of homes, if they could speak, might give us many concrete terms. Every craft has its special terminology. These craft words are often simpler than the book words of the student. A few examples follow, from core-making: *green-sand*, *chill cores*, *caking*, *binder*, *sweeps*, *strickling*, *slick*, *ash vent.*

On the same subject, however, we read of *colloids*, *hydrol*, *glucose*, and *sulphite*. These are "hard words" from Latin and Greek, related to more formal study and experience in the fundamental science. While word analysis lies beyond the scope of this book, writers and readers will find a little knowledge of Latin and Greek prefixes, roots, and suffixes not only helpful, but interesting. In the examples just given, for instance, *colloid* is Greek for "glue form"; *hydrol* is Greek for "water" with a complicated reaction; *glucose* is Greek "sweet" plus a Latin suffix connected with hydration: *sulphite* is Latin "sulphur"

plus another Latin suffix meaning "salt formed from the corresponding *-ous* acid." Terminations like *-ite*, *-ate*, *-ous*, by the way, put chemistry in the front rank for exact terminology.

At another level, words like *factor*, *proposition*, *procedure*, *transpire*, *receive*, *to present* also have precision, or would have if they had not lost it through careless use. Many writers use these when all they mean at the time is *thing*, *offer*, *plan* or *method*, *happen*, *get*, and *give*.

A little knowledge of Latin and Greek prefixes, roots, and suffixes will also prevent loose usage which tends to wear off the fine edges of these precision words. Their function is mainly logical. Though they come chiefly from Latin, without them we cannot write English precisely if there are any logical relationships to be considered. Here etymology, or word history, plays a part, though it does not override usage. The dictionary (and some handbooks) will give information on modern meanings as they have changed from original ones.

CLEARNESS

Precision is not the only requisite of language in scientific writing. Some of the most precise technical parts have to be explained and illustrated. Symbols, formulas, and equations have a high density of meaning which must be reduced, unless the reader has special training or mathematical imagination. Because of the special requirements, the language of mathematics, though recognized as the most exact and universal language known, is not easily understood by nonmathematicians. And even the language of mathematics, when it was being worked out, had to define terms and operations by means of something outside the system, *i.e.*, in words. The interested student has only to look at his text in mathematics to be impressed with the importance of words in making clear to the mathematician himself this most exact and universal language. This claim for words is not made to overemphasize one medium at the expense of another, but to point out the need of blending the two.

Though it is only a maxim of common sense that any writing intended to convey information should be clear, *clearness* as a word is hard to define except in other words that are also definition proof. Perhaps the best way to solve the practical problem is to consider the usefulness of familiar language. If the facts can be communicated in familiar words and word groups; if at times the subject matter—too difficult or specialized for anything but technical words and word

groups—can be translated into familiar phrasing which leads the reader in the right direction, even though it alone cannot take him all the way, some clarity will result. Obviously, even the term *familiar* is capable of two meanings, for highly technical words and word groups become familiar ones to the scientist through knowledge and use. Even he has expressed his thoughts in concrete rather than abstract terms.

A writer is safe in proceeding on the principle that, in any informative writing, either the essential facts must be made familiar to the reader or they must already be familiar to him. Application of this principle means taking some chance of giving the reader more than he needs. Exact estimate of the other man's knowledge is impossible, though groups of readers can be roughly gauged, especially if one belongs to the same group. This requirement is perhaps most vividly brought out by consideration of how producers of films and of drama, how publishers of books, try to gauge the knowledge and interests of their public in the selection of their subjects and the treatment. The producer of a technical discussion has a similar purpose. To attain it, he may adopt one of the two possible fundamental policies:

1. Assuming that his reader knows a great deal and is willing to look up what he does not know in technical dictionaries or books;
2. Explaining all but the common technicalities in the text, in footnotes, or in a glossary, without making the reader feel that his capacity is underrated.

The second is evidently a safe, conservative policy. Most writers probably work out a compromise between the two. They are careful to define for their readers new terms or any which would be difficult to look up; they assume a certain level of familiarity with the older. established ones.

Familiar idiom is the secret of clear sentence structure. All words have two aspects: meaning and grammatical or idiomatic use. Some words are very hard to define except in their use as parts of a phrase or sentence. The word *to* is an example. It means "in the direction of a destination"—a definition which shows what a madhouse life would be if we had to explain all common words. But it also means something like this: a signal of the infinitive construction, one of the most effective phrases in English, as "Water tends to flow."

Many words like *to*, such as *will*, *with*, *and*, *but*, *without*, *them*, *get*, etc., have in them more grammar than concrete meaning. Count the words in any statement, even the most precise or technical, and you will always find some of these. The equation $x^2 + y^2 = r^2$ is not an exception to this rule, if it is stated in familiar language as follows: x multiplied by itself added to y multiplied by itself is equal to r multiplied by itself.

Problems of clearness in sentence structure may be solved through practical grammar. Participles and infinitives, which are especially effective in English, are easier to use than to analyze. Idioms are more flexible than rules. The expression *The bridge is being built*, though often severely attacked during the past hundred years, is now recognized as standard and exact. No one could doubt what it means.

In idiomatic English the determining factor is not so much logic as a natural feeling for the language. On the negative side, such language may be described as the kind which the average foreign-born person will not use, even though many educated foreigners are more careful of their English than the natives are. To those who have the natural feeling, the parts of speech are known by their function rather than by their form. A noun may be a modifier as in *a rock* garden; and even an adjective, changed to a noun, may be an object in *He won over the natives*. Adverbs and prepositions are often closely tied up with verbs. An old-fashioned rule says: Never end a sentence with a preposition. In many cases the word in question is a preposition which commonly occurs just after a verb. For example: "We stopped at the first house we came to." In this combination *to* belongs with *came*. The same sentence shows omission of the relative pronoun object, which is another good old English idiom.

Clear division of sentences and their parts is largely a matter of logical punctuation. Learn the exact uses of the period, semicolon, and comma and you will know how to write clear sentences, clauses, and phrases, or *vice versa*. Otherwise, the problems of division, arrangement, and connection for the sake of clearness, are much like the corresponding problems of precision in sentence construction, except for the larger part played here by familiar idioms.

In arrangement, the precision rule of subject, verb, predicate complement is varied by an easy idiom. "It is interesting to see the

monkey riding on an elephant." In this case the real subject is the phrase beginning with *to see*. Put it back in subject position, and the logical relation is immediately seen. Yet, we are thoroughly familiar with the natural form of expression by which we replace the subject with a sort of blank word *it* and shift the real idea to the end. Compare the similar constructions using *there is* and *there are*.

Modifiers may also be shifted from the position next to the modified part. "That house was the finest—the red one." The appositive phrase, usually following closely on the subject which it modifies, is perfectly clear when put after the predicate. "Periodically, the geyser gushes from the ground." The modifier of the verb (or is it of the whole statement in this case?) will not be misunderstood when put before the subject.

Not only the relative pronouns, like *which*, but also those which are used in sentences and independent clauses, like *it*, *they*, *those*, have connective force because they refer to some previous subject or object. Pronouns are savers of repetition. Nevertheless, in scientific writing there is a strong tendency to repeat words for connection. These repetitions are not "clumsy"; they are definitely meant to serve clearness.

Connectives point up the arrangement of sentences and their parts. They advertise the plan. Like all advertising, they may be crudely or skillfully handled. There are several devices for joining the various units of language. Some of these are of the type called correlatives, which are essentially double connectives. Conjunctions, coordinate and subordinate, are supplemented by conjunctive adverbs, relative pronouns, relative adverbs, and interrogative pronouns or adverbs (provided these are used in dependent clauses). Phrases may be used, as well. Prepositions, and their equivalent phrases, are also connective in function. Consider the following examples, taken from scientific works quoted elsewhere in this textbook:

> The changing road requirements are by no means the concern of road people alone, *for* all circles of business and public are affected.

The coordinate conjunction *for* introduces an independent clause.

> *If* an efficient trackage system is to be provided *for* the volume of road traffic *that* demands accommodation, there is new work ahead —much and difficult work.

The subordinate conjunction *if* introduces a dependent clause, of the adverbial type. The preposition *for* introduces an adverbial phrase, the object of the preposition being *volume*. The relative pronoun *that* introduces a dependent adjective clause.

Conservation in this sense is *not only* applied to the prevention of loss by leakage and evaporation, *but* is *also* represented *by* controlled methods of production, controlled amounts of production, controlled refining, *and* the most efficient use of the crude oil in its fractions.

The correlative expressions *not only* and *but also*, made up of adverbs and the coordinate conjunction *but*, connect the main verb phrases *is applied* and *is represented*. The coordinate conjunction *and* connects the final noun phrase *the most efficient use* with the preceding noun phrases which are objects of the preposition *by*.

Steel and iron production, *on the other hand*, is not usually considered a process industry.

The conjunctive phrase *on the other hand* connects this sentence with a preceding one.

This stabilizing effect of the oil is similar to the effect of a smoky atmosphere *where* particles of dust and soot collect around particles of atomized water and thus prevent them from joining into larger drops and falling *as* rain.

The relative adverb *where* introduces an adjective clause which modifies *atmosphere*. The coordinate conjunction *as* connects *rain* in parallel relation with *them*. The construction is complicated by the fact that *them*, referring to *particles*, is object of *prevent*.

Two of the gates had been kept free of ice by the use of compressed air and heating, *so as to* open within four hours' notice.

The connective phrase *so as to*, made up of the conjunctions *so* and *as*, and the preposition *to*, introduces an infinitive adverbial phrase.

After construction, the ditches would be left to maintain themselves—*instead of* drains they would become reservoirs to hold water adjacent to the road shoulders.

The prepositional phrase *instead of* introduces *drains* as its object.

An unbelievable amount of research has been carried out to devise

methods of determining *when* a well is not quite straight and to work out means of drilling so as to keep the hole perfectly straight.

The interrogative adverb *when* introduces the clause which follows *determining* as an object.

Connection by means of repetition may also be achieved through the parallel construction, in which the grammatical form and sometimes also particular words are reiterated. The effect intended is to indicate similar function or weight by similar phrasing. In outlines and tables parallelism is a necessity. In continuous writing, organization is greatly aided by this device which keeps elements in their place and ties them together at the same time.

Successful connection by means of connectives, pronouns, repetition of words, and parallel construction, will be found in the selection in Chapter Six, on "Laws in Science."

Example: Clearness in Sentence Construction[1]

In its simplest form the telescope consists of three parts: a large lens to collect light from a distant object and to form an image of the object with this light; a magnifier (usually called an eye-piece) to magnify the image; and some sort of tube to hold lens and eye-piece the proper distance apart. All additional parts of a complete telescope are adjuncts to its essential parts to enable the observer to concentrate on observing and to lose no time in holding, setting, and moving his instrument.

Example: Clearness in Sentence Construction[2]

Universal Gravitation.—There is a tendency for every body in the universe to move toward every other body. This tendency arises out of the fact that every particle of matter attracts every other particle of matter with a force whose direction is that of the line joining the particles. When the masses of these bodies are small, this attractive force is small; but the attraction between two bodies like the sun and the earth is very large. It is this force of attraction between the sun and the earth which causes the earth to describe its orbit about the sun. The weight of a body is the attractive force of the earth on the body. This force pulls the body toward the center of the earth.

[1] Fath, Edward A., *Through the Telescope: A Story of the Stars*, p. 2, Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1936. Reprinted by permission of the author and the publishers.

[2] Smith, Alpheus W., *The Elements of Physics*, 4th ed., pp. 27–28, McGraw-Hill Book Company, Inc., New York, 1938. Used by permission of the author and the publishers.

The greater the mass of the body, the greater is this pull and the greater the weight. The farther the body from the center of the earth the less is this pull. Hence, the weight of a body varies with the altitude and also the latitude at which the observations are made.

Newton found that *the force of attraction between two small bodies or between two spherical bodies of any size is proportional to the product of their masses and inversely proportional to the square of the distance between the centers.* This law may be written as

$$F = k\frac{M_1M_2}{R^2}$$

where F is the force of attraction, M_1 and M_2 the masses of the bodies, R the distance between their centers; and k a constant known as the constant of gravitation.

Words.—Familiar language is the simplest solution of problems of clearness. What familiar idioms do for the sentence structure, familiar words will do for the vocabulary. Language of this kind, both words and idioms, draws heavily upon simple Old English and Old French elements, in contrast to bookish Latin and Greek terms. Short words like *piled* are usually more familiar than longer ones like *accumulated*. The more elaborate words are useful for precision purposes, but when the question is one of clearness, plain English is the best.

Even two-letter words like *it*, *to*, *as*, *so*, *if*, *or*, *is*, etc., together with many of the same kind which are very little longer, do much work in English. When used *idiomatically*, these will be understood instantly by all except foreign readers. But reading them is much easier than writing them in the natural combinations. An unabridged dictionary or even, for that matter, a desk dictionary will show how they can be used in a wide variety of meanings and connections. Naturally, the writer who is master of these idiom words will have greater resources in clear sentence structure than the one whose equipment is confined to technical and Latinate terminology.

What are the most familiar words in the language? Probably those which are most commonly used. Lists have been prepared by various investigators, such as Edward L. Thorndike in *The Teacher's Word Book* and Godfrey Dewey in *Relativ Frequency of English Speech Sounds.*[1] The first ten words of Dewey's word list are *the*, *of*, *and*, *to*, *a*, *in*, *that*,

[1] Simplified spelling.

it, *is*, *I*. These are useful as grammatical tools. About halfway through the same list, which totals 1027, occur such words as *drive*, *electric*, *thirty*, *carry*, *force*, *ground*, *plan*, *taking*, *third*, *change*, *cost*, *perfect*, *products*, *street*. By rough count, the percentage of one- and two-syllable words (in Dewey) is over 90. Three-syllable words make up less than 9 per cent; four-syllable words (31 in 1027), and five-syllable ones (11 in 1027), less than 1 per cent. In Thorndike's list there are no five-syllable words in the first 1000, and only five in a group of 2500. The other percentages are also proportionately lower for long words.

The figures show that polysyllables are not the only important means of speaking and writing in English. On the other hand, a few "big words" are so common that they are not "hard words." Examples, from both lists, are: *approximately*, *organization*, *satisfactory*, *opportunity*, *everybody*, *individual*, *representative*, *necessary*, *situation*, *business*, *remember*, *together*.

INTEREST

Clearness makes easy reading by economizing the reader's energy. Interest goes farther, and by stimulating his attention makes him want to read, even though it may be hard. The scientific problem, of course, is solved by the writer. The reader's purpose is to understand thoroughly the steps by which the writer worked it out. The reader, therefore, must be stimulated to take interest in the process of solving the problem.

As in mass development, so in detail development, or in the language parts, the best means of stimulating interest are variety and suggestion of values. In sentences or statements these may be used in the same way as in paragraphs, on a smaller scale. In words, vividness can be developed to the highest degree; and vividness, for technical writing, may be defined as suggestion of the values inherent in observation. For example, if paint is subject to "cracking, checking, and scaling," the reader is invited to imagine, not something fictitious but actual events in the life of paint which he can see, touch, and even feel the desire to prevent or mend.

In *sentence structure*, variety is the greatest resource of interest, because it includes most of the other resources. Division (sentence length) arrangement (word and word-group order), connection (use of different connectives, including idiomatic omission), and selec-

tion of kinds of sentences and sentence parts, all contain many possibilities of change. A few simple options only will be illustrated here.

Long and short sentences are both good, but a mixture of them is always more interesting than monotonous uniformity of size. Less simple than difference in size, but perhaps more effective, is difference in phrasing. The value of grammatical knowledge as an aid to varied expression is often overlooked.[1] Among other things, sentence beginnings and sentence endings, as well as interior parts, may be changed in many ways without disturbing the basic subject, verb, predicate complement (or object) structure. In addition to the straight declarative statements, questions, exclamations, and commands are often used effectively in scientific writing.

Example: Variety in Sentence Construction[2]

It is said that during a technical talk given by a particularly experienced highway engineer the question was asked, "What is the most important phase of road construction?" His answer was, "Drainage." The question came back immediately, "What is the next most important phase?" The speaker answered more emphatically, "*Drainage.*" Once more the tenacious seeker after wisdom asked, "Well, after drainage, what?" The speaker more emphatically than ever thundered, "DRAINAGE!"

Examples: Variety in Sentence Structure[3]

The series of studies has not been completed, and only two dusts have been used to any extent; but it is felt that the results obtained are sufficiently definite to indicate that:

1. It is possible to vent dust explosions without causing structural damage.

2. Fixed glass offers too much resistance to permit dependence upon it alone for the release of explosion pressures without structural damage.

[1] The late C. H. Ward. an unusually successful English teacher, wrote a textbook based largely on this point, with the suggestive title *Grammar for Composition.*

[2] Eno, F. H., *op. cit.*, p. 51. Used by permission.

[3] "Dust-Explosion Tests Suggest New Building Practices," *Engineerng News-Record,* 110 (14): 437, Apr. 6, 1933. Used by permission of *Engineering News-Record.*

3. Many types of venting equipment, hinged doors, windows and panels may be satisfactorily used to release explosion pressures, provided sufficient venting area is available.
4. Vents near the source of ignition are more effective than those located some distance away.
5. The venting area required varies for different dusts.
6. Secondary explosions are more difficult to vent than primary explosions.
7. A definite reduction in pressure results as the venting area is increased.
8. Pressures may be released by lowering the resistance of fixed glass by means of outside glazing or by scoring.

Words may be varied by selection from the three levels of language previously described: technical, nontechnical but precise, and familiar.

The other principal way is to find synonyms for words which do not need to be repeated in identical form for clearness. It is inadvisable to use all the synonyms in Roget's *Thesaurus*. Baseball reporters who substitute *frame* and *stanza* for *inning* may cause their readers to laugh with them or at them, but scientists are under no obligation to strain after farfetched substitutes. When the temptation to repeat arises, it may be well to change structure rather than single words. Prevention is better than patching up, especially if the patch is a "purple" one.

Yet the skillful, unaffected use of synonyms makes easy and attractive reading. Since a synonym is never the exact equivalent of the word replaced, it will give the reader a new impression, perhaps a new value in the subject, or even a new rhythm to recall his wandering attention. For varied vocabulary carries change in sound, as well as in meaning, along with its movement.

Vividness in words and phrases is another such resource of interest. Since science deals so largely with things to be observed, either as evidence or as illustration of its laws, vividness is in place. Figures of speech are allowed so long as they do not falsify the facts, but they are not very common in scientific writing. Observation words, on the other hand, play a large part, for the simple reason that in the natural sciences, all the senses, from sight to smell, are active in the process of learning. Sight, sound, motion, touch, smell, taste, and temperature make up a convenient practical classification. Words like *blue*, *siren*, *slide*, *corrugated*, *smoke*, *sugar*, and *freeze* get and hold the attention of a reader better than words like *qualification*, *reason*, *attitude*, *in-*

ference, which are more suggestive of logical thinking than of living in an active, interesting world.

Some technical terms are vivid. For example, *gear*, *tractor*, *shale*, and *blight* give us mental pictures of concrete things; and *osmotic*, *ultraviolet*, and *vitreous* make us visualize, at least in part, certain qualities or properties of things.

Yet the greatest storehouse of vivid words in English is that familiar vocabulary of simple common words which carries so much of the load of everyday communication. In the lists of Thorndike and Dewey already cited occur such terms as *avenue*, *black*, *blue*, *book*, *bread*, *chair*, *coal*, *cold*, *corn*, *cream*, and scores of others which suggest concrete things or their qualities. In the first 500 (according to Thorndike) the various senses are represented by *grass*, *sing*, *ride*, *rain*, *milk*, *garden*, *winter*.

All readers are human. When they read they are adding to their experience by an indirect method which is always a little less interesting than the direct method of actual living with things. It is by direct experience that they gained their first knowledge. What is familiar to them came first of all through the avenues of the senses. If the unfamiliar is presented to them through these avenues, they will try more energetically to understand it than they will if they are told to close their eyes and ears and meditate on abstract ideas.

EXAMPLES: VIVID PHRASING

Subject	*Words and Phrases*
Road repair	frost boils, heaves, pitting
Cohesion	sticky, cementing material
	fine, wave-beaten beach sands
Floriculture	thawing and freezing during winter
	warm spells
Emulsion	milk souring, lumps of butter fat
Osmosis	swelling of prunes, cooked
Petroleum	cracking of gasoline, antiknock quality
Water treatment	curds, flocs, mud sticks to curd
Cleaning garments	flash point (of cleaners)
Chinaware	chipping, glaze, translucent
Vitamin C	turnips, tomatoes
Cement	marl, shale, slag, pulverized, clinkers
Tin	cry

In addition to the words just listed, which are mainly nonfigurative there are many technical terms which originate in figures of speech.

Consider such expressions as *S curve*, *I beam*, *Y bridge*, *U turn*, *gear teeth*, *catwalk*, *toe of a slope*, *nose of a torpedo*, *hood of an automobile*, *shoe of of a tire*. These are metaphors or compact comparisons with things familiar to the sight. The method may be extended to other sensations, and we have *soft shoulders*, *air pockets*, *sour soil*, *hardpan*, *green concrete*. The examples afford ample evidence of the fact that, in the applied sciences, the concrete and tangible materials dealt with may be described in language which is vivid as well as concrete.

Example: Interest in Language[1]

PROLOGUE: WHY I AM A FISHERMAN

No three words in the English language stir one's soul with such mystic power as does the title of this little book. Jobs, family responsibilities, social obligations, political entanglements, and even the deadliest of worries—all go hang when we hear those magic words, "Let's go fishing."

How well I recall that banner day of boyhood when my big brother Frank said, "To-morrow I am going to take you fishing on the Susquehanna." I see mother packing our lunch the night before—sandwiches, a dozen of them, fruit, big pickles canned by her own native skill, and dozens of her wonderful home-made cookies. Vividly I recall how far into the night I watched Brother carefully preparing spoons, lines, and rods for the Great Day. I slept little that night. It was Christmas Eve dated June thirtieth.

At daybreak we were on the beautiful river; and what a beautiful river the Susquehanna is! All through the day we fished. Sometimes we were over the deep holes, then beside the grass patches, at other times by the big rocks where the goggle-eyes held forth. At Hawk Rock, a great pyramid rising from the river, I had my first swimming lesson. By nightfall I was dead tired, sunburnt, and hungry, but our day had been gloriously successful. We had caught several black bass, three Susquehanna salmon (pike perch), and many yellow perch and rock bass.

I shall never forget the catching of my first black bass. It must have amused my brother immensely when I dropped rod and reel and hauled in my prize hand over hand. And he weighed less than a pound. True, not physically large—but mighty in his influence on my whole life. That first bass of mine thirty years ago awakened instincts and opened up a golden pathway to the sport that has meant to me no end of keen pleasure, good health, and a deep appreciation of the out of doors.

[1] Reitell, Charles, *Let's Go Fishing*, pp. 1–3, Whittlesey House; McGraw-Hill Book Company, Inc., New York, 1931. Reprinted by permission of the author and the publishers.

Lucky is the lad who before the age of twelve has had the opportunity to go on a fishing trip. Most fortunate is he if some old crony has taught him some tricks and good pointers which made his early fishing adventuresome and successful. For by such experiences is a true fisherman made; and with the making is effectively created a lover of the great outdoors, a first hand student of nature, and a real conservationist of those things that are of prime importance in our national welfare—our forests and our waters.

The language of scientific writing may be compared to a modern highway. Precision is the main thing, like the road itself—solid, level, straight, and wide—a thorough job. Clearness corresponds to the guiding lines, signals, and safeguards. Interest is like the features along the road which add pleasure to driving. These include center and side stretches of greenery; signs and stopping places for a view of mountains, rivers, or historical sites.

Such interest accessories are not actually needed by the motorist who wants only to get to the next town on time. The same is true of scientific writing. Interest is not a matter of necessity, like precision and clearness. Still, it may give the reader relief and renewed energy, just as seeing the Cumberland Gap or the Lincoln Memorial may help a driver to withstand the strain of modern traffic.

THE NEXT TO LAST DRAFT

The problems of progressive writing which have been discussed so far can be almost entirely solved in a series of drafts before the stages of revision and final copy. Some fine points of finish will naturally have to be postponed. In a sense, every draft but the last one is a tryout.

The big things to be done are: determining the proper choice of a kind of functional writing, such as letters, reports, and articles; expanding the outline by means of paragraphs; preparing and fitting in the graphic parts; and, what is perhaps hardest of all, writing out the statements in precise, clear, and interesting language.

No matter how many drafts are written—and they should be as many as are needed for solving these main problems—there are certain methods for putting thoughts on paper which will save much time and labor later on.

1. Do not begin a new paragraph near the bottom of a page. Use a new page.
2. Leave extra margins and extra spaces between the lines, for proofreading and corrections to be written in.

3. Clip rather than paste all graphic material which will appear in the final copy.

Problems

1. List at least ten technical or semitechnical terms used in five of the following: baseball, football, golf, tennis, motoring, dancing, contract or auction bridge, aviation, state fair exhibits, laboratory work, field trips, fraternity and sorority activities, intramural activities, harvesting, carpentry, auto repair work, radio, or hunting.

2. List the prepositions used in fifty pages of a standard scientific textbook, article, or bulletin. Note which are used with the greatest frequency.

3. Do the same with clause connectives (conjunctions, relative pronouns and relative adverbs, and conjunctive adverbs; for example, *but*, *which*, *when*, *however*). In this case, record in a parallel column the punctuation used with the clause connective.

4. List fifty technical words of the scientific type found in advanced textbooks or theoretical discussion and analyze their prefixes, suffixes, and roots, if possible. These will usually be from Latin and Greek. Examples are: *di–ox–ide*, *semi–perme–able*, *sub–lim–ation*, *volt–meter*, *homo–gen–eous*, *super–hetero–dyne*, *re–in–oculate*. Look up the words in the dictionary. If the derivations of the prefix, stem, and suffix are given, record them with the word and its parts. If not, look for other words having the same beginning, middle, and end parts, and become familiar with the meaning of these through repetition.

5. Look up the following words, nontechnical but precise, found in standard scientific discussion: *mutually*, *populated*, *calculate*, *diminished*, *subsequent*, *liberated*, *preponderance*, *accumulated*, *evaluate*, *simultaneous*.

6. Do the following familiar words form part of your writing vocabulary? They are found in textbooks and bulletins related to applied science problems. They are not only easy to understand but they are vivid. Examples are italicized in the following phrases:

> *bubbles* begin to reach the surface
> salts which are packed with fresh meats soon become *brine*
> when a car wheel rolls on a *smooth track*
> each turn of wire *cuts* all the lines of force
> sulphur is a light yellow *powder*

Write ten sentences using similar simple words which help the reader visualize an object or an activity.

7. Select five simple sentences from papers you have previously written or from early drafts of paper work in progress, and expand them into complex sentences. Remember that of the original subject-verb-object or subject-

verb-predicate complement structure, only the verb part cannot be expanded into a clause. In addition to the subject, the object, and the predicate complement, the modifiers of these and of the verb or the general predication or statement, may be amplified into clauses.

8. Select five complex sentences from illustrative selections in Chapters Five and Six and reduce them to simple sentences. In other words, take the subordinate clauses and compress them into phrases or single words.

9. Take a familiar equation from chemistry or mathematics, and state in words and ordinary sentences what it means. Examples are:

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$
$$x^2 + y^2 = r^2$$

10. Analyze ten illustrative sentences given in this chapter and the preceding one in accordance with the S V P and S V O formulas. (It is recommended that clauses, phrases, and the intermediate type which are hard to classify be taken as a whole for their function, rather than divided into their parts.)

11. Analyze the punctuation in relation to the sentence construction, of all the illustrative sentences in this chapter and in Chapter Six. Make a table of parallel columns, with the various types of clauses in one column, and the corresponding punctuation marks in the other.

Chapter Nine

The Final Copy

INSPECTION

In professional writing, the final copy resembles the finished product of an industrial process. Before being shipped, it must be inspected. An inspector may be defined as a being otherwise human whose feelings are absent while he is at work. He has mechanical eyes and ears which respond automatically to any defect or variation from the standard.

In the industry of publication, the human machine who acts as inspector is called a proofreader. Only such an expert can catch all mistakes in usage and form, especially when questions of typography are mingled with those of correct English. Proof sheets, called galley proof or page proof, provided with wide margins, are returned to authors, and the white space is used for corrections and suggestions.

If so much care is needed for published matter, it is even more necessary for the writer himself to check on his letters and reports which are not printed. The student writer, above all others, should be his own inspector. He may legitimately pay a typist to copy his revised manuscript in its final form, but not to correct his mistakes. Some typists are not competent to correct mistakes. The writer should submit accurate copy and not expect or demand that the typist correct his errors in writing.

The English instructor is a more reliable and legitimate helper in correction. Teachers are usually strict in grading. However much credit they give for concrete material and clear thinking, careless copy will reduce the grade. Grades, in spite of all the criticism heaped upon them, do not differ much from the returns gained by a professional worker. The student or preprofessional is paid in merit instead of money, and in most instances college merit bears a definite relation to later salary returns.

For these reasons, the student as well as the professional writer must be his own critic, as free from prejudice as possible. In criticism, our best friends and our worst enemies are not so useful as the unbiased observer who can see both good and bad in their true colors. The impersonal job of revision, though not an exciting one, is far too vital to be attempted without purpose, plan, and the right facilities.

SYSTEMATIC REVISION

The major phases of revision are criticism and proofreading. Criticism has to do mainly with scrutinizing and checking mass and detail development: content, organization, paragraphing, graphic parts, and language considered for general *effectiveness*. Proofreading has to do definitely with noticeable variations from *standard usage* which, if overlooked, will damage the writer's reputation. These variations may be in grammar, formal punctuation, spelling, mechanics, and spacing.

Revision could begin anywhere if we could be sure of checking everything. Thus, if we know that spelling is weak, we may correct that first; then test for grammar, paragraphs, etc. A better plan, however, is to keep criticism and proofreading apart.

The size of the composition units to be corrected makes different methods advisable. For paragraphs or groups of sentences, the best plan is to *rewrite* the improvements on new pages, numbered 1*a*, 1*b*, 2*a*, 3*a*, etc., in correspondence with 1, 2, 3, etc. Sentences or shorter items are more conveniently changed by *writing-in* between the lines, provided the progressive copy has been double spaced. Occasionally, the upper and lower margins may be used, after the manner of galley-proof changes, for a line or two running from left to right. The right- and left-hand margins are not so well suited for sentence rewriting, because the direction will be up or down. However, smaller alterations, in words, punctuation, etc., may be indicated at left or right, with or without proofreader's marks. Regular symbols of the latter type are useful to know; they may usually be found in the front or back of desk dictionaries.

The following example illustrates the convenience of the writing-in method for matter that is too brief to be rewritten on another page and too simple to need marginal marks.

```
                     principle
      The chief principal in the process is that in

the treatment of
treating the final invested wax model, the melted

wax runs out, leaving an opening, wherein the

molten bronze may be poured. in.
```

The corrections are:

Sentence structure: (Effectiveness)	Cross out *treating*, and insert *the treatment of*. The error is a dangling modifier which also causes clumsy repetition of *-ing* words.
	Cross out *in*. The error is redundancy. *Wherein* already contains the *in* idea.
Logical punctuation: (Effectiveness)	Put period after *poured*. The previous change makes this one necessary.
	Put comma between *out* and *leaving*, for the non-restrictive modifier.
Spelling: (Usage and meaning)	Cross out *principal* and insert *principle*. The noun refers to an idea, not a person.

In this case, proofreader's marks might have been used, but in general they are not to be recommended when they complicate rather than simplify revision. The term *proofreading* in this chapter is intended merely to indicate simple correction of mistakes in usage, in contrast to critical consideration of changes for increased effectiveness in statement. Perhaps the example shows that these two overlap. That being true, the writer will find it an easy matter to criticize and proofread at the same time, but it is a good plan to make two *final* checks: one to criticize, one to proofread.

The writer must know how to detect flaws in his copy, as well as where to find the better forms to replace them. Some previous knowledge and practice are necessary, but no one is so perfect that he can get along without standard works of reference on composition, usage, and mechanics. For increased effectiveness in composition, the present book aims to give practical help. English handbooks and dictionaries also help in criticism; they are even more necessary for

correcting mistakes in usage. Then, there are more special books like Roget's *Thesaurus* or Fernald's *Synonyms*, Fernald's *Connectives*, Ward's *Grammar*, and the Chicago or the United States Government style manual. For minimum needs, the composition textbook, handbook, and dictionary are sufficient, especially for the correction of common faults. The present chapter, like Chapter Eight, does not attempt to provide a handy summary of the handbook. The aim is, rather, to illustrate how continually a writer needs to consult such works of reference.

A glance at the handbook, or at various progressive drafts, should convince any writer, whether student or professional, that there are a great number of possible faults and that revision is an exacting job. It would be an impossible one if the previous stages of the writing process had not been handled with energy and imagination. The preparatory assembling of materials and outlining, followed by the progressive writing out of the one or more drafts, must be done with enthusiasm not too much hampered by worry over mistakes. Criticism and proofreading also take energy, but of a more cool-headed variety. After the first draft is written, the greatest need is for a system that will insure the writer against overlooking mistakes.

CRITICISM

The first stage of revision should answer questions like the following:

Are the contents complete and accurate?

Is the organization logical and clear—adapted to the subject and to the reader?

Is the general development by paragraphs and graphic parts precise, clear, and interesting?

Is the detail development, by language parts, precise, clear, and interesting?

If these questions seem too vague, the writer may check more closely on topics in Chapters Four to Eight. In the case of the letter, report, or article, he may decide to change the basic form, or, what is more likely at this stage, to modify important portions of it to satisfy the general requirements of the kind of writing. The introduction, body, and conclusion, with their paragraphs and graphic parts, may be tested for selection, division, arrangement, and connection.

The sentence structure and attendant logical punctuation, and the choice of words, may be challenged again.

A little analysis of good examples will show that their effect of easy reading results from precision and clearness as much as from variety and emphasis. In fact, their flexibility and freedom can be explained in terms of rules in the handbook, especially those relating to sentence construction, punctuation, and choice of words. The chances are that the writers have spent hours of training in the elimination of plain mistakes.

The handbook, therefore, is a great help in all problems of revision, not only in matters of usage, but also in general effectiveness, as may be seen from the following table.

TABLE FOR CRITICISM AND CORRECTION

Stage	*Problems*	*Aids*	*Methods*
Kinds: Letters, reports, articles	Selection and review	Books on composition, on letters, and on reports	Writing over
Paragraphs and groups, in Introduction, Body, and Conclusion	Development: selection, division, arrangement, connection	Books on composition and handbooks	Writing over
Graphic parts	Development: selection, division, arrangement, connection	Books on composition and on graphic methods	Drawing over, writing over, clipping
Sentence construction	Statement: selection, division (punctuation) arrangement, connection	Books on composition, handbooks	Writing in
Words	Selection	Books on composition, handbooks, dictionaries, books of synonyms	Writing in

In one of these books, four of the major divisions are unity, clearness, emphasis, and diction. The rules under these heads are based on long experience in the correction of student papers. If the English instructor finds them useful in diagnosing the problems of student writing, obviously the student, or even the professional writer, can benefit by using them in his self-criticism.

But there are fifty rules for general effectiveness in this particular book, and what writer will want to check his progressive copy fifty times (not to speak of some fifty more times for usage)? A simpler plan is possible for those who know a handbook thoroughly. The table on page 135 may be of help.

PROOFREADING[1]

Proofreading covers questions of language and of printer's practice. A professional copy reader is competent to mark flaws in both of these aspects. Under language, he will often have to question meaning as well as form. In the present discussion, however, language form (with manuscript or copy form) is the main problem. Matters of meaning have been included under criticism. It is difficult to separate general effectiveness from formal correctness, but if the writer will act as his own critic before acting as his own proofreader, he will not miss vital points of meaning; at the present stage he will then be free to concentrate on points of grammar, formal punctuation, spelling, mechanics, and spacing.

Grammar here includes agreement, cases, tenses, etc. rather than general structure of the sentence. It might be called *formal grammar*.

Formal punctuation includes use of the apostrophe, quotation marks, etc., rather than logical, structural punctuation, or the marks for sentences, clauses, and phrases.

Spelling includes handling of double consonants—choice between *ei* and *ie* and the like—rather than forms of different meaning, like *accept* and *except*. An important special feature is compound words.

Mechanics includes matters of print, such as italics, syllabification, capitals, etc. In addition to general problems, there are many special ones connected with letters (headings, addresses, etc.) and reports (footnotes, bibliographies, etc.).

Standard Usage.—All the questions involved here may be grouped together as belonging to *standard usage*. The practical

[1] For proofreader's marks see "Preparation of Copy for the Press," *Webster's Collegiate Dictionary*, 5th ed., pp. 1272–1273, 1936.

problem is twofold, however. When in doubt, writers want to know where to find reliable authority for the language or for the display. In the first case, they are more or less dependent on language experts who give rules and examples in handbooks, grammars, and dictionaries. In the second case, they are in the long run dependent on printing experts who give similar information in manuals of style.

The word "authority" in this connection must not be misunderstood. It is not the authors of handbooks and manuals who determine usage. They merely record the best practice in their respective fields. These records are compact; they save us the labor of studying the entire current and previous history of the subject.

Originality in matters of usage is allowable but dangerous. Few serious writers wish to be considered eccentric in form, because noticeable variations from standard practice will always distract attention from the all-important meaning. A spelling reformer may be justified in writing *relativ* for *relative*. His example is an argument for simplified spelling. Yet it does not make easy, uninterrupted reading on subjects which are not connected with language.

The scientific writer's problem is usually not to be original in form but to make a vital contribution to science. His reputation is risked when he departs from standard procedure, either in his handling of facts or in his presentation of them. If he writes *sliping* for *slipping*, *he had did* for *he had done*, or fails to indent his paragraphs, he may antagonize his reader as well as discredit himself. Actual mistakes of this nature stand out. They may be due to carelessness rather than ignorance. No one demands the style of literary genius in practical, informative letters, reports, and articles. But if the style seems to imply carelessness, there is danger that the accuracy of the facts may be questioned. It is not at all unlikely that a careless writer may be suspected of being a careless worker.

Grammar.—In present practice, such expressions as are listed in the first column of the following table are not grammatically correct.

Substandard	*Standard*
conditions is	conditions are
there is seven	there are seven
gave to Smith and I	gave to Smith and me
them things	those things
Brown's murder (if Brown was murdered)	the murder of Brown

me getting a traffic ticket was no crime	my getting a traffic ticket was no crime
seen it	saw it
drug it	dragged it
left it lay	let it lie
if they would have come	if they had come
every man got their money	every man got his money
ran rapid	ran rapidly
like it does	as it does
can't find none	can't find any

The rules governing these cases are difficult to formulate without exceptions and qualifications. Grammar seems at times to conflict with idiom. A better statement about this apparent conflict would be: mechanical application of rules should always be tempered by adaptation to the particular meaning and context. For example, a certain student who had learned that the gerund (noun form in *ing*, like *running*) is usually preceded by the possessive case, insisted that he should always write: "I saw his coming down the street." In this particular statement *coming* is not a gerund but either a participle or an infinitive. In more senses than one, circumstances may alter cases. The heroine in *Gentlemen Prefer Blondes* uses *gave it to she and I* language. This level of speech is well known to linguistic experts as that of hyperelegance. The speaker wishes to be especially choice in manner. Having heard that *you and me went* is bad English, she (but the male of the species often acts the same way) assumes that *gave it to her and me*, or *between you and me* is also vulgar. There are two kinds of vulgarism: the honest illiteracy of those who have not had the opportunity to know better, and the pretentiousness of those who live beyond their language resources. It is easier to forgive the former type of vulgarism.

At the opposite extreme from the *between you and I* language is the *left it lay* or *leave it lay* language. This is simply crude. On the stage or screen it is typical of the vaudeville hoofer or the gangster.

The difficulties, and there are many, lie in the range between these two extremes. The handbook, when used merely for quick, ready reference, is probably not a sufficient safeguard against hyperelegance; but for the avoidance of crude, obvious errors it offers reliable advice. In all frankness, it must be admitted that many college students need this advice. In the case of any complex and subtle question, the student should consult his instructor for explanations which cannot be compressed into a handy work of reference. A

supplementary book of great value in dealing with genuine difficulties in this field is C. H. Ward's *Grammar for Composition*, which stresses the elimination of the most damaging errors.

Formal Punctuation.—The difference between logical punctuation and formal punctuation may be seen by the errors in the following example:

> Every rule has it's exception handbook rules are no exception to this rule.

Logically, there should be a semicolon or a period before *handbook*. Otherwise, the meaning is destroyed or, at least, held up until the reader can solve the puzzle. Formally, there should be no apostrophe in *its*. Otherwise the meaning is probably clear, but the usage is not standard. All punctuation is ruled by usage, but in the second case logic plays practically no part, except where there might be confusion between the meaning *it is* and the meaning *belonging to it*. Since we write *the dog's bark* it might seem logical to write *it's bark*. Usage rules that the personal pronouns in the possessive case, like *his*, *hers*, *its*, *theirs*, *ours*, *yours*, do not take the apostrophe. *Whose* follows the same rule.

This example is characteristic of all formal punctuation. Logical or illogical, and many uses are logical enough, the custom of the best writers and printers always gives the right answer. It is always:

Standard		*Substandard*
He said, "I will come."	*not*	He said "that he would come."
Pronounce the *r's*.	*not*	Pronounce the *rs*.
The list reads as follows:	*not*	The list reads as follows;
Dear Sir:	*not*	Dear Sir;
Mr.	*not*	Mr
G. D. Smith	*not*	G D Smith
W L W (radio station)	*not*	W. L. W.
nobody's business	*not*	nobodys business
the farmer's house	*not*	the farmers house
the dog and its bark	*not*	the dog and it's bark
isn't	*not*	isnt

These formal punctuation marks have a genuine use. Quotation marks indicate the exact words of a speaker or another writer. The apostrophe stands for an omission of letters, long past or recent. The colon shows that a statement or a series is to follow. The period

indicates an abbreviation. The hyphen is used to divide a word into syllables and also to combine two words into one. The fact that a single mark can mean both division and combination is typical. Usage rules, not logic. The colon may stand before a phrase or a whole sentence which begins with a capital letter (as in formal correspondence). The period is not used for contractions, even for those which do not contain an apostrophe.

No simple rules can be given. Those in the handbooks are adequate and detailed, as they have to be in covering numerous special cases.

Spelling.—English spelling is difficult for two main reasons. The pronunciation has changed since the spelling, originally intended to agree with the pronunciation, was established. Hence *thought*, *wreck*, *knowledge*, *does*, *row* (of seats), *row* (quarrel), and many other words are full of silent letters and varying sounds. In addition, the English language has been greatly influenced by foreign spelling habits, especially those of Old French, Latin, and to a less extent Greek. Troubles with *ei* and *ie*, *c* and *g*, *pre* and *per*, and words like *pneumonia* and *diphtheria* have resulted.

There are three ways to attack this problem. The first is to learn the simple rules of English spelling, for in spite of irregularities, there are some useful rules which cover thousands of cases. The second is to master enough etymology for practical needs. The third is to get the habit of visualizing spelled forms in general, and to learn the standard spelling of each new word once and for all. Even in revision, the writer whose spelling is weak can well afford the time to check all the words in his copy on this threefold basis of rules, etymology, and visualized form.

The following popular spelling mistakes can easily be corrected by simple rule:

planing for *planning*
planeing for *planing*
changable for *changeable*
vallies for *valleys*
crys for *cries*

Any handbook will give the needed directions for doubling a final consonant and dropping or retaining a silent final *e* before an added suffix, and for forming plurals of words in *y*, *ey*, etc.

A little knowledge of Latin, Greek, and native English prefixes, roots, and suffixes will help in thousands of technical terms, as well as in the following cases:

> *accommodate*, *definite*, *similar*, *quality*, *accept and except*, *affect and effect*, *precede* and *proceed*, *perform* (not *preform*), *disappoint*.

A great majority of English words, however, have to be learned singly, with general help only from trained habits of visualization. Pronunciation helps in some cases, as in *environment*, but in others pronunciation must be supplemented by visual memory of the letters as they are arranged. Hard words often cause less trouble than common ones, because many of the latter have to be unlearned and relearned. For revision, the only safe policy is to check on every doubtful word, with special attention to those contained in lists of common errors, either in a handbook or the writer's own collection.

Abbreviations and compounds present special problems of spelling. Their formal punctuation is the period and the hyphen. But how and when to abbreviate and compound are other questions. The first can be answered best by the dictionary and special lists. The second can be partially answered by rules.

Abbreviations may be found in the dictionary, entered under their initial letters or syllables. The best aid for geographical terms is the *United States Postal Guide*. The rule for formal writing is: Be sparing of abbreviations in the text. This direction obviously does not apply to graphs, tables, columns, footnotes, bibliography, appendix matter, and the like. In the text, scientific writers are no doubt strongly tempted to save space where there are many dimension terms that would be easily understood. In these cases, the student writer is advised to consider whether he cannot reorganize the material in tabular or column form, and avoid breaking the rule. Numbers and technical symbols, to be discussed later, are not abbreviations in the strict sense of the word.

However, there are exceptions, like *Mr. M.D.*, *mm.* (and other metrical system terms), *C.* and *F.* (for temperature), *in.*, *yd.*, etc. Students who use these departures from the formal rule should find examples in standard works to justify their practice.

Compounds may be found in dictionaries (indicated by dash or double hyphen rather than by single hyphen) and in special lists.[1] The underlying principle is one of unity. When two or more words are to be taken as having a unit meaning, they are logically compounds, yet in actual practice they are written as separate words (provided this form would not indicate a different meaning), as hyphenated words, or as single words. There is no absolute rule covering all cases.

Some tendencies are: to compound modifiers, as *8-inch plank* (but *8 inches* or *eight inches*), *cast-iron work*, but *of cast iron;* to fuse one-syllable words with following ones, as *woodwork*, *sawmill;* to separate longer words from the following ones, as *filigree work*, *reference book*. But usage varies greatly.

Handbooks and dictionaries are useful for familiar terms like *half-mast*, *halfback*, *father-in-law*, *sixty-three*, *one-third*, *cooperation*, *all right*, *altogether*, *anybody*, *anyone*, *itself*, *outdoor*, *prewar*, *per cent*. These should be learned as spelling forms. The student writer is free to choose the simpler forms, where authorities conflict (they unfortunately do, because of varying usage among different publishers) as in *today*, *to-day; one half*, *one fourth* (as a noun; the modifying form, as in *one-fourth finished*, should be with the hyphen).

No doubt spelling troubles are due partly to the small size of print and script which we usually read. To counteract this disadvantage, a magnifying glass is useful in revision. Editors of one of the leading desk dictionaries have found such glasses effective in the search for typographical defects. As a supplement to correction, the student with drawing experience may be interested to experiment with *lettering* on large cards the standard forms of the words he misspells. The connection between space-perfect and letter-perfect workmanship is close in expert sign-making, blueprinting, typewriting, typesetting, linotype operation, monotype work, multigraphing, and multilithing. Why not in practical English?

Mechanics.—Except where it overlaps with formal punctuation, mechanics is mainly a matter of printer's types and symbols, or their

[1] See GAUM, CARL G., and HAROLD F. GRAVES, *Report Writing*, pp. 307–308, Prentice-Hall, Inc., New York, 1929; SYPHERD, W. O., and SHARON BROWN, *The Engineer's Manual of English*, pp. 77–85, Scott, Foresman & Company, Chicago, 1933; United States Government Printing Office, *Abridged Style Manual*, pp. 55–86, Washington, D. C., 1935.

equivalents in handwriting and typewriting. Italics (and handling of titles), syllable division, capitals, and numbers (with technical symbols) make up the general problems.

Here are some of the questions which are bound to come up!

Shall we write *Paints and Varnishes*, "Paints and Varnishes," or Paints and Varnishes, for the title of a report? All are correct, under varying conditions. Standard practice is: names of complete publications (books, periodicals, bulletin series, etc.) in italics; names of sections of complete publications (bulletin titles, magazine articles, etc.) in quotation marks. A title used on a title page or a cover is not usually printed in italics or enclosed in quotation marks.

Shall we write *Quercus* or Quercus? Foreign words or words of recent foreign origin, except very common ones like *item*, *data*, *garage*, (italicized here because they are cited as words) are generally indicated by italics. The footnote abbreviation *op. cit.*, Latin for "the work cited," follows this rule.

How shall we divide words at the margins, to avoid zigzag effects? Printers have an advantage in being able to "justify" or space out their lines, and they try to divide as sparingly as possible. These methods may be imitated in handwriting but not in typing.

The rules are all based on the *syllable.* American usage favors pronunciation as a guide; British usage favors etymology, which for all practical purposes is equivalent to spelling; for example: American *knowl-edge*, British *know-ledge*. Neither of these can be considered wrong. For copy (as contrasted with print), it seems unfair to insist that either the pronouncing system or the spelling system should be carried out consistently. There are many exceptions, and compromise is often the best way out.

A few simple regulations should be observed:

Never divide is the best policy for monosyllables like *free*, words like *again* having a single-letter syllable, short words like *city* and most words with short endings like *ed* in *ended*, *le* in *people*. Short prefixes like *de*, *in*, *un* are more suitable for setting apart.

Divide by syllables, when necessary, in such words as *tempt-ing*, *dwin-dling*, *na-tion*, *advan-tage*, *pro-ceed*, *pros-perity*. The conflict between spelling and pronouncing systems is evident in these cases; but the results are not radically wrong, as they are when the reader faces *une-ven*, *e-ver*, *rambl-ing*, *loc-king*, *pass-ed*, *thro-ugh*, and *differenti-al*.

In case of doubt, the dictionary will give a customary division. The hyphen is the mark used, and should not be mistaken for the dash or the double hyphen in compounds.

What do capital letters stand for?

In single words and simple word groups they indicate names of particular persons and places, and particular titles, as *John Smith; Pasadena, California; Dr., Professor* (when connected with a name). Modifiers formed from place names are also capitalized, as *French, Indian.*

The same objective, of lending special emphasis to a distinctive name, seems to underlie titles of books, periodicals, and articles, such as *Elements of Physics*, *Chemical Abstracts*, etc. Here the first letters of all important words are capitals; in print the choice between words is often avoided by use of capital type for all the letters. Headings are handled much like titles, but paragraph heads often omit capitals after the first one. Longer elements, such as sentences, lines of poetry, lines in letter headings, rows of items in tables, etc., carry initial capitals to show where they begin. This use is merely formal, since space and punctuation have already made the point clear. We are again subject to formal usage, and the only safe method is to follow the custom.

Shall we spell out numbers? We should when they are short (in spelled form, as *eight*, *eighty*), when they are rare in the context, and when they are used to begin a sentence. Technical symbols like those for *degree* and *number* are sometimes expressed in words or in their abbreviations.

Date numbers, street numbers, fractions, page references, and dollar items, are rarely spelled out. Names of numbered streets (to avoid confusion) and cent items (which are easy to write) are often given in words rather than numbers. A general tendency where figures are numerous in the text is to avoid the spelled forms. For example:

> Of the clear slabs 43 occur on the treated sections. Ten of these slabs range from 8.6 to 21.2 feet long; 25 slabs occur on the untreated sections, 7 of which range from 6.4 to 20.8 feet in length.

Formal punctuation of numbers, with the period for decimals and the comma for thousands, as 10.5; 1,556, will not cause trouble to those who are accustomed to handling figures accurately. In tables,

graphs, footnotes, and bibliographies, figures always predominate over spelled-out forms. A few examples will show how this policy is feasible in standard practice.

A satisfactory size is 2 by 3 feet, with a depth of 8 to 12 inches.
. . . at the rate of 1¼ gallons per square yard.
. . . about 0.1 per cent.
The table on page 13 . . .
. . . 60 to 65 parts by weight . . .

It may seem that special parts of letters and reports, such as the heading, inside address, salutation, and complimentary close; tables of contents, graphic elements, footnotes, bibliographies, and appendix matter, involve specially difficult problems of mechanics (and formal punctuation). A little analysis, however, will show that the standard usage in general mechanics and formal punctuation needs only to be adapted to these particular needs. These special parts are all illustrated in other chapters. Perhaps the most troublesome thing about them is the spacing.

Spacing.—Spacing should be checked in the next-to-last draft, but it cannot be perfected until the copy is put into finished shape. This final copy will be presented to an instructor, a client, an employer, a correspondent, or an editor. Not only must the copy be legible; the form must also be standard.

For margins, the student may find it helpful to mark light pencil lines on all four sides. These may be erased later. Pages may be numbered at the top right-hand corner or bottom center. Paragraphs should be indented or, in case the block system is used, set off by double spacing. The space between words should be sufficient for visibility and legibility; and between sentences or similar parts, such as those marked by a colon, this should be doubled. The amount of white space around graphic parts should be liberal and well balanced. Special care is needed where a pictorial element is "cut in" the text. For footnotes, bibliographies, and other special parts, the same general principles of visibility, accessibility, and symmetry hold good. Details will be found in later chapters.

The table on page 146 covers the principal problems of standard usage (including spacing).

TABLE FOR PROOFREADING AND CORRECTION

Stage	*Special problems*	*Aids*	*Methods*
Grammar	Agreement, case, tense, adverbs, negatives, etc.	Handbooks and grammars	Writing in or marking in margins
Formal punctuation	Quotations, contractions and possessives, words of introduction, abbreviations, syllable divisions and compounds	Handbooks, manuals of style, and dictionaries	Writing in or marking in margins
Spelling	Rules, derivation, single words, abbreviations, compounds	Handbooks and dictionaries	Writing in or marking in margins
Mechanics	Italics (titles) syllable divisions, capitals, numbers, and symbols	Handbooks, dictionaries, and manuals of style	Writing in or marking in margins
Final copy	Spacing, with legibility, and paging	Handbooks and manuals of style	Rewriting, typing, inserting graphic parts

The table for proofreading, like the previous one for criticism, is not proposed as the last word in systematic revision. Rather, it is a sort of first word, urging the writer to schedule his corrections for one thing at a time.

The problems concerned are undeniably tedious, but they are exceedingly vital to the student, especially in the matter of grade. They demand more time and more method than is usually given to them. Those whose preliminary training in good English and clean copy is weak need to make up for their handicaps. Those who have a tendency to give way to carelessness should force themselves to make their own repairs in their papers.

The final copy is not always the writer's last chance to correct and revise his writing. Students are sometimes permitted to hand in corrected papers, even after this stage. A useful method for this kind of follow-up writing is:

1. Allow an entire page for every page to be corrected.
2. Write over large parts, such as paragraphs, in normal-sized handwriting or typewriting. Use the space left for analysis and further illustration of the revision problem.
3. Letter or write over in larger form than normal, the small parts, being careful to make them space perfect as well as letter perfect. Use the extra space as above.
4. Insert or bind in the correction pages to appear opposite (at the left of) the marked parts on the original copy.
5. Keep records on small cards (or if convenient, in larger form) of all mistakes, even the most minute ones, and classify these according to some systematic grouping. Date the records, and keep score on them, taking an inventory at least once a month.

Problems

1. Check a page of your own writing for such basic grammatical problems as the fragment sentence, the comma fault, agreement of verb and subject, agreement of pronoun and antecedent, case of pronoun, tense and mood of verbs, auxiliary verbs, confusion of adjective and adverb, conjunctions, double negatives. Make a table of these ten foundation factors of grammatical precision, and mark the number of mistakes in the respective rows or columns.
2. Check a page of your own writing for structural punctuation in regard to the comma, semicolon, colon, period, exclamation point, question mark, dash, parentheses and brackets, quoted matter, and overpunctuation (usually with the comma). Make a table of these ten points and record your score as in Exercise 1.
3. Check a page of your own writing for formal punctuation and mechanics, with respect to italics, quotation marks, titles, syllabication, capitals, abbreviations, numbers, footnotes, bibliography, paragraph indentations. Arrange and record results, as in 1 and 2.
4. Check a page of your own writing for spelling troubles. Consider mispronunciation, forms easily confused, etymology, *ei* and *ie* forms, doubling final consonant, dropping final *e*, plurals of words ending in *y*, other plurals, compound words, common errors, and typographical errors due to slips in handwriting and typewriting. Arrange and record as in 1, 2, 3.
5. Continue the method used in Problems 1 to 4 with respect to (a) choice of words, (b) general sentence structure, (c) unity, (d) coherence or clearness, and (e) variety. Arrange the total classification in such a way that you can score yourself on the basis of 100 points, approximately 20 for each main division. Take off one point for each fault.

6. Write a letter of transmittal. (See Chapter Five for the requirements.) After composing the letter effectively for contents and arrangement, lay out the final copy on one or two pages, with special consideration of symmetry and of formal punctuation and mechanics. Study the use of the colon, the comma, the period, capitals, titles, numbers, abbreviations, courteous formulas, positions of the heading, inside address, and other formal parts. Determine beforehand whether you will use open or closed punctuation, indention or block arrangement, and be consistent in these matters. Before making the final copy, correct the letter carefully by the methods suggested in the previous exercises, or other methods which are equally strict. Check and recheck for particular mistakes.

7. Correct a page of your own copy by applying standard proofreader's marks. (See the dictionary or handbook for lists and examples of use). Correct the "proof" with marginal or written-in corrections; then rewrite.

8. Correct three pages of your own copy—first, for general effectiveness in relation to your purpose; and second, for standard usage in grammar, punctuation, spelling, and mechanics. Reverse the order and see whether you get better results. Write a short report on these results. In revising for general effectiveness, use the method of writing over on a separate page for all material which amounts to one or more sentences. For usage, write in the corrections, in the margins or between the lines.

9. Make a small card collection of your most common errors, as determined by your own observation or instructor's corrections. Head each card with the handbook rule number or brief label identifying the mistake. Give an example of the correct form, written or printed in large letters (as in the problems for Chapter Two) and the incorrect form smaller and less conspicuous. Classify the mistakes according to the headings, and transfer them to a table. Assemble from ten to fifty cards, and compress the table into one page of standard size.

10. By means of your handbook or dictionary, check your knowledge of the following technical terms: dangling participle, parallel construction, passive voice, connotation, triteness, idioms, fragment sentence, clause, phrase, predicate adjective, conjunctive adverb, restrictive clause, prefix, slang, obsolete words, hyphen, complimentary close, suffix, Anglicized plurals, improprieties, subordination, correlatives. List these on cards or in a report of two to three pages, with a heading and a brief definition or example of each term.

PART II

WRITING PRINCIPLES APPLIED

Chapter Ten

Reports

APPLICATION OF PRINCIPLES AND METHODS

In Part I of this book, the general principles of presenting facts, feelings, and ideas have been discussed. They have ranged from the methods of selecting a topic for writing, the procedure for outlining, the expanding of the outline by building up paragraphs, constructing sentences, and selecting words, to the assembly of these various parts into the whole composition.

Now, in the study of the forms of functional writing required in the pursuit of a profession based upon the applied sciences, these principles of writing and standard arrangement of the material on paper will be presented. For, in putting in black and white the facts of applied science, special ways have been evolved. Indeed, the procedure for applying the basic principles of writing and the use of standard methods are similar to adapting and applying the general rules and formulas of science. Both, until they are put into actual uses for definite purposes, are abstract, remote, uninteresting, and theoretical. To undertake with competence the specialized form of writing used in informing others of the significance and applications of science to the use and convenience of man, the student on his own initiative should make a comprehensive review of the indispensable general principles given in Part I.

KINDS OF REPORTS

The subject matter for factual writing, as has been noted already in Chapter Three, comes from personal experience, observation, inspection, and research. The resultant papers, *i.e.*, the accounts recording and interpreting these facts, are usually designated as reports on experience, on observation, on inspection, on research. They are *always* written *after* an activity, or a part of an activity, has been completed. No report can be written unless it is preceded by

action. Then the report writer with a detached point of view records what he has done or seen.

Classification of the resulting discussion depends upon the predominating means of acquiring the facts. In active practice, generally all the methods of gaining information are required in varying degrees in every report. The same materials, the same objects are under scrutiny. The differentiation arises through the relation of the writer to the facts. Take, for example, a topic such as the Norris Dam. According to the writer's relation to it, he would write an experience, an observation, an inspection, or even a research report. If he had been employed on the project, he could tell about his particular activity in connection with its construction. If he had gone to Tennessee to see the conspicuous features of the dam, he could write an observation report. If he had had experience on another project of a similar nature and had been sent to view this one with discriminating judgment, he could write an inspection report. Finally, if he were making a study of hydroelectric projects to verify or discover some of the underlying principles, he could use the Norris Dam as an example in a research report. The relation of the writer to the facts of his report must never be overlooked.

In developing skill for future report writing, the student will do well to begin with accounts that will draw upon actual work in which he has participated, either as a gainful occupation or as a hobby.

PROCEDURE IN REPORT WRITING

From the standpoint of coherent writing, technical reports follow the procedure of all good written discourse. Through training, experience, observation, or research, the report writer must be able to discuss the activity out of his actual knowledge. First, he picks out the word that comprehensively represents his topic; next, he analyzes it for range and restrictions required by his knowledge and reader adaptation; then, he works up a complete statement that formulates the problem for which he will present the solution in his report. In standardized report procedure, this complete sentence is designated as *the statement of the object.* This has already been put into some definite form, of course, in the process of gathering the data, *i.e.*, the facts for which the particular project was undertaken. Because of its use in the fact-finding stages, it is more than the topic sentence.

Originally, in the rough draft form, or working hypothesis, it has been the guiding principle in discovering the pertinent facts. *In good report writing, the object is never implied. It is always clearly stated just as the proposition for argument.*

Description of Apparatus.—The report is developed by breaking up this object into its component parts, *i.e.*, the writer presents the plan he used in solving the problem. His writing method is that discussed in detail in Chapter Six on Expanding the Outline. He lists and describes, if necessary, the instruments and materials which have been used. He tells how these instruments have been set up, and what raw materials have been combined. For instance, if he were telling of the manufacture of paper, he might describe the various machines required at the different stages of the process and their relation to one another. Often in this section, photographs or diagrammatic sketches are used to supplement the description in words. Thus the reader can visualize the equipment.

Narration of Procedure.—After the description of apparatus comes the account of how it worked and what was the result. Sometimes the description of machines and accounts of their operation are combined; in other words, the report writer indicates the function of the apparatus as he describes it. Again, discussion or comment on what happened, conditions under which the work was done, the facts that helped or hindered the solving of the problem—anything that needs explanation to justify or to make clear the procedure—are interwoven in the account of the procedure, or at least immediately follow. It is usually easier for the inexperienced writer, however, to separate description of apparatus and narration of method.

Graphically, the relation of the various parts of any technical report might be put thus:

description of apparatus
Object (statement of problem)
discussion-results-conclusions (solution of problem)
narration of procedure

In the simplest reports, such as the technical student has to make in his first two years in college, all these items are demanded in brief form only. They include simply the statement of the object, the

description of the laboratory equipment used, a concise statement of what happened when the equipment was put to work, and the conclusion.

The object is the topic sentence for the entire report. Paragraphs of description and narration, developed according to the methods in Chapter Six for paragraph growth, are needed to give a picture of the apparatus, and to tell how it worked. Paragraphs of explanation are required in the discussion, and concise, technically accurate, and clear sentences are necessary for the statement both of the object and of the conclusions. The results are often stated in mathematical formulas. The conclusions are in words. The material for any report can always be assembled under the headings of *object*, *description of apparatus*, *method of process*, or *procedure*, *discussion of the relation of apparatus to its performance and accomplishment and to the object*, *results*, and *conclusions*. If the beginning report writer will always keep these headings in mind when he is sorting his facts preparatory to assembling them, he can organize them with directness and effectiveness. It is the usual and standard order for developing the routine technical report.

Discussion on Results.—In the first attempt at report writing, the student will find that the emphasis is put on the precise statement of the object, accurate description of the apparatus, an exact account of the method of going about the work, and the actual operation of the apparatus. Discussion, especially in the underclass laboratory reports, is relatively slight. The student must demonstrate that he has a knowledge of the details of apparatus and method before he can undertake discussion, *i.e.*, interpretation of the results of the arrangement and manipulation of apparatus. Extended comment on results is seldom expected of the beginner. In the detailed discussion of reports presented in the succeeding chapters, therefore, the stress will be upon the development of skill in precise statements of the purpose of a paper, the accurate and vivid description of machines and plant layouts, and in accounts of how machinery works, or of what processes or procedures have been carried on in certain situations, or places, or under certain conditions.

An excellent pattern for a simple report is the letter of Benjamin Franklin to Peter Collinson which describes Franklin's experiment for "drawing the electric fire from clouds." Though the object of the letter is not so formally stated and the divisions are not so sharply

marked as in most present-day reports, this letter includes the indispensable points of a report.

BENJAMIN FRANKLIN TO PETER COLLINSON[1]

(Read at the Royal Society, December 21, 1752)

Philadelphia, 19 October, 1752

SIRS:

Object

As frequent mention is made in public papers from Europe of the success of the Philadelphia experiment for drawing the electric fire from clouds by means of pointed rods of iron erected on high buildings, etc., it may be agreeable to the curious to be informed that the same experiment has succeeded in Philadelphia, though made in a different and more easy manner, which is as follows.

Description of apparatus

Make a small cross of two light strips of cedar, the arms so long as to reach to the four corners of a large thin silk handkerchief when extended; tie the corners of the handkerchief to the extremities of the cross, so you have the body of a kite; which, being properly accommodated with a tail, loop, and string, will rise in the air like those made of paper; but this, being of silk, is fitter to bear the wet and wind of a thunder-gust without tearing. To the top of the upright stick of the cross is to be fixed a very sharp-pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribbon, and where the silk and twine join, a key may be fastened.

Procedure
(1) *Method of using apparatus*

This kite is to be raised when a thunder-gust appears to be coming on, and the person who holds the string must stand within a door or window, or under some cover, so that the silk ribbon may not be wet; and care must be taken that the twine does not touch the frame of the door or window. As soon as any of the thunder-clouds come over the kite, the

(2) *Result of using apparatus*

pointed wire will draw the electric fire from them, and the kite, with all the twine, will be electrified, and the loose filaments of the twine will stand out every way, and be attracted by the approaching finger. And when the rain has wetted the kite and the twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckles. At this key the vial may be charged; and from

[1] *The Works of Benjamin Franklin,* compiled and edited by John Bigelow, vol. II, Letter XCII, pp. 262–263, Knickerbocker Press. 1887. Used by permission of G. P. Putnam's Sons.

Conclusion electric fire thus obtained spirits may be kindled, and all the other electric experiments be performed which are usually done by the help of a rubbed glass globe or tube, and thereby the sameness of the electric matter with that of lightning completely demonstrated.

B. Franklin

The student writer will profit by giving careful descriptions of laboratory apparatus and procedure. It is basic for all that follows, for the greater part of the writing practice will report activities with which the student writer becomes familiar in the field and laboratory through one or more of the methods of collecting facts. Since the writing will conform to the writing demands that he will find in later college courses and in his future professional practice, he can become well grounded in the underlying principles of report writing through the simple reports. Finally, at the risk of overemphasis, it is well to recall the thought of the opening paragraph of this chapter: *In the longer pieces of professional writing for which the technical student must prepare himself, the fundamental principles of all good writing are applied.* They are applied in report writing as the principles of mathematics, physics, and chemistry are applied to the related fields of applied science of which they are the base.

FACTUAL DESCRIPTION AND FACTUAL NARRATION

Before proceeding to an extended discussion of the different types of reports, and at risk of some repetition, it will be well to consider the outstanding features and the method of presentation of factual description and of factual narration, which are involved in the description of apparatus and the account of how it worked.

Factual Description.—The object of any factual description in words is to make the reader or the listener see the material things—the equipment, the mechanism and contrivances with which the applied scientist works, and the resulting structures that he raises—see them clearly, vividly, accurately. Description is demanded always in that section of the professional report which gives clear photographs of the apparatus used in an experiment. In every laboratory report in physics, in botany, in chemistry, in zoology, some notation must be made concerning the material needed for the experiment, the testing and the tested materials and apparatus. In the beginning

laboratory courses, the descriptions are often sketches accompanied by a few words. In actual professional practice, the assumption is that standard equipment is so familiar as to require no detailed description. A machine, for instance, is described by its serial number, or by reference to the well-known standard form. Where this knowledge can be assumed, there is no reason for wasting time and effort to describe equipment in words. However, when the student is learning the methods for future professional presentation of scientific facts, he is required to use the complete form; thus, he is to demonstrate that he has observed closely enough to know the parts that go into the whole—parts that are implied when short cuts are used. The student writer can check the adequacy of this section of his report by determining whether his word pictures convey clearly the same details in their proper relations as a sketch or photograph would bring them out. Frequently, a sketch or photograph accompanies the description in words.

Apparatus and structures may be described in several ways:

1. They can be named, *i.e.*, briefly pictured by assembling words that will indicate type, dimensions, and performance, such as a *reinforced-concrete skew arch; 1000-hp. steam turbine; multiple-walled boiler tubes; a bridge consisting of a central double-leaf bascule span of 80-ft. clearance, with a 60-ft. approach span at each end; four 3-hp.gate motors.* The combination of words to describe machinery and structures briefly is limitless.

2. To these brief, compact, comprehensive, descriptive phrases, details are added according to the complexity of the apparatus, the background of the reader, and the length of the whole discussion. Several paragraphs may be required to make a clear picture.

At times, the single phrase may suffice; at times, an extended description may be required to enumerate parts and to indicate their location and their function. For the beginner in factual description, it is better to err by giving too extended description of apparatus than too meager. Extended description is especially desirable in advanced laboratory reports, where the student should demonstrate to the instructor that he knows what are the various parts and their functions.

Factual Narration.—After the materials and the equipment have been adequately pictured, the next step in a report is to give an account, or a narrative, of what was done with them and what hap-

pened. It is a slow-motion picture which shows how the machine worked, the result when the load was applied. This type of writing is designated as factual narration. The reader sees the equipment and the material not at rest but moving, working, and producing results. In actual practice, factual description and factual narration can hardly be separated. But every good technical writer must be able to report in words what he has worked with, what he has done, and what happened.

Factual narration, the running account of how apparatus works and what happens, is always present in report writing, for by this means are recorded the effects of the work, actions of machines and actions of materials when put to use. The simplest way is to tell what happens step by step, from the start to the finish. Then, a generalization can be made upon the type of procedure under which the particular method can be classified, or the difficulty of the work. Sometimes, the narrative covers the account of how standard tests have been applied. Frequently, one aspect of procedure can be given in one sentence, as "Its operation was a process of causing a piston to move upward in a cylinder by pressure of steam, and then condensing the steam to cause it to move downward."[1]

In the examples which follow, factual description and factual narration are functioning in the accounts of processes and procedures. Note in the account of the photographing of natural lightning, the simple directions for "fishing for flashes."

EXAMPLE: FACTUAL NARRATION[2]

The photographing of natural lightning was and still is of inestimable value to the investigator. A study of anything that lasts only a few thousandths of a second is, of course, utterly impossible. But while it lasts it can be made to make a perfect record of itself, suitable for minute scrutiny later on. Pictures of lightning bolts were made in the early days of photography. Neither high-speed emulsions nor high-speed shutters were required. The camera is merely pointed (at night) toward a part of the heavens where a bolt is likely to occur, and with the open lens a perfect record of the flash

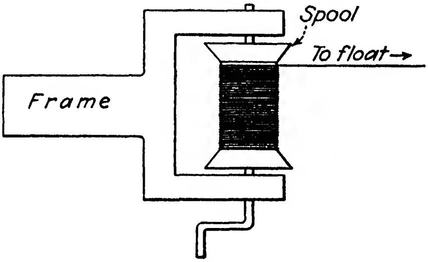
[1] GRAY, GEORGE W., "Full Steam Ahead," *Atlantic Monthly*, 159 (1): 119, January, 1937. Used by permission *Atlantic Monthly*.

[2] PALME, A., "Photographing of Electric Arcs," *The American Annual of Photography*, 51: 245–246, 1937. Used by permission of *The American Annual of Photography*.

is obtained. Try it some day yourself. "Fishing for Flashes" is an interesting hobby, particularly if, by luck, you get a real close bolt. Have your diaphragm set at f:6 or f:8, and close the shutter immediately after each flash. A fresh film is advisable for each stroke, to avoid crisscrossing of images. In doing this, you may sometimes be surprised to find, instead of a black stroke, a transparent stroke on the negative, which gives a so-called "black lightning" effect on the print. This odd result, known by the name of Clayden effect, after the man who first discovered it, has never been fully explained, but is probably a secondary reversal of the latent image on the film.

Example: Factual Description and Narration Concisely Combined[1]

In measuring the approximate flow of a stream, the usual method is to time floats over a certain distance along the channel. This requires two men, one



Reel for fishing cord used in velocity measurements.

to place the float, the other to time it when it passes a definite line. Errors are caused by eddies and crossflow in the stream. Better results can be obtained by one man by the use of the following method: First, a line is stretched across the stream between two posts or trees upon which are marked division points for velocity measurement. Then, by wading or the use of a boat, the observer releases from each of these points a float to which is attached 100 ft. of common fishing line mounted on a simple reel, similar to that shown in the illustration, which can be constructed from an ordinary spool and a short piece of wire. By this method the exact time for the float to traverse an exact 100 ft. is measured and errors due to cross-currents are eliminated. Depth soundings and the calculation of volumes of water are made in the usual way.

Note in the example which follows that the account of the method of applying the creosote to the lumber precedes the general descrip-

[1] Goodwin, G., "Streamflow Measured by Simple Method," *Engineering News-Record*, 103 (17): 66, Oct. 24, 1929. Used by permission of *Engineering News-Record*.

tion of the two vats. This is followed by a detailed description of the vat for the hot oil, the heating plant, and the device for handling the hot creosoted lumber.

Example: Factual Description and Narration[1]

A careful study of all the common methods of applying creosote to lumber indicated that the hot and cold open-tank bath process was the most practical for the conditions to be met at the experiment station. By this method the lumber is first placed in a creosote bath at a temperature of 200 deg. F. and left for 1½ hours. This causes expansion of the air and water in the pores of the wood. At the end of this period the lumber is removed from the hot creosote bath and dropped immediately into a cool creosote bath, where the cooling of the air and water in the pores of the lumber forms a partial vacuum, and as a result a large amount of preservative is drawn into the lumber. The lumber is permitted to remain in the cool bath for 1½ hours and then is lifted out and placed upon a drain rack adjoining the cooling tank for at least the same length of time, to permit surplus oil to drain from the lumber into the cooling vat. A mixture of one-half coal-tar creosote and one-half used motor oil is employed.

The two vats are the principal element of cost in the construction of such a plant. They were made by removing both heads from four 55-gal. oil drums and one head from each of two other drums, and then butt-welding the drums together to form a long cylinder. This cylinder then was split down the center with a welding torch, to form the two semi-cylindrical troughs or vats.

The vat for hot oil was set between two 4-in. concrete walls, held together with ½-in. round tierods, and by flat slabs of concrete 6 in. deep by 12 in. wide at each end of the vat. Iron lugs on the wall support the vat. Special care was exercised in closing the joint between the firebox and top of the vat to keep the fire from reaching the inflammable oil in the vat.

Openings were left at both ends of the fire box, and two openings were provided at the side to facilitate stoking. A draft was provided by removing one head from another oil barrel and mounting a sheet-iron smokestack over a hole near the opposite end, pushing the open end of the oil barrel into one of the open ends of the fire box and chinking the opening around it with heavy clay. This stack can be moved from one end to the other, depending upon the direction of the wind.

To obtain the full capacity of the vat, wooden cross-bars are used with a loop of wire at each end to be hooked over bolts embedded in the concrete

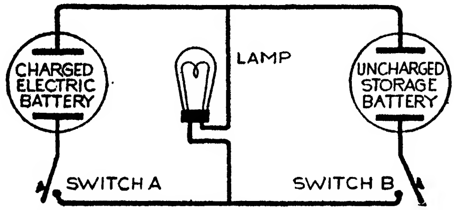
[1] Riesbol, H. S., "Field-creosoting Plant for Small Construction Job," *Engineering News-Record*, 113; 819, Dec. 27, 1934. Used by permission of *Engineering News-Record*.

side walls. After the lumber has been put in the tank, the bars are fastened down across the top of the tank to keep the lumber submerged.

In handling the hot creosoted lumber, a Z-shaped hook has been found effective, about 12 in. long, made of ½-in. round reinforcing bar with one end of the horizontal Z-legs sharpened to a dull chisel point that can be readily inserted between planks.

Example: Factual Description with Diagram[1]

As a preliminary to the explanation of Baernstein's mechanism, let us consider first a simpler type of thinking machine which was designed later by another of Dr. Hull's students, R. G. Krueger. Krueger was a young electrical engineer before he took up psychological studies, and he seized on the storage battery (or polarizable cell, as it is also called) as the key to his conditioning apparatus. The arrangement which he set up may be diagrammed as follows:



The hookup is simple. When switch *A* is closed, the entire left half of the diagram becomes a closed circuit; the current from the charged battery flows through the lamp and causes it to glow. Similarly, when switch *B* is closed, the entire right half of the diagram becomes a closed circuit with the lamp; but there is no energy in the uncharged storage battery; therefore, the lamp gives no response. When both switches are closed simultaneously, the current from the charged battery not only flows through the lamp, but it also flows through the uncharged cell, and some of its energy is stored there. Thus the process of conditioning consists of charging the storage cell, and after this is accomplished switch *B* alone can invoke light. Prolonged pressing of *B* will exhaust the stored energy, thus accounting for the "experimental extinction." But if you leave the exhausted cell passive a few minutes, a certain chemical readjustment will take place, a "spontaneous recovery" such that if you now press switch *B* the lamp will glow feebly—a mechanical analogue of memory.

Krueger's working model included not only the conditioned stimulus represented by switch *B* but a whole series of them. Thus, after conditioning

[1] Gray, George W., *The Advancing Front of Science*, Chap. XIV, "Thinking Machines," pp. 272–273, McGraw-Hill Book Company, Inc., New York, 1937. Used by permission of the publishers.

B to *A*, it was possible to condition a new circuit *C* to *B*, and after that a circuit *D* to *C*, and so on for a considerable sequence. This provided a chain of reactions comparable to those of Pavlov's experiments in which, after conditioning the sound of the bell to the showing of food, Pavlov conditioned a flash of light to the sound of the bell, and then the sight of a luminous disk to the flash of light, and so on. The heart of the Krueger model is the uncharged storage cell with its capacity for accumulating energy (a process analogous to learning), and its capacity for exhausting its energy (experimental extinction), and its capacity for spontaneous recovery (remembering).

Definition.—A third type of general presentation in which every report writer should be proficient is the defining or explaining of terms to set a limit to his particular problem, and to simplify and interpret technical terms so that the uninformed may understand and the scientist may not misunderstand. Note the definitions implied in the following:

The telescope gives us an eye for the distant, and the camera gives us an eye to remember. Physics has furnished a third eye, the microscope, for seeing the world of things minute.[1]

Definitions may be logical, *i.e.*, one-sentence statements in which terms are put into general classes, and the identifying peculiarities that differentiate each individual in the class noted. Or a term may be developed to make an expanded definition in which the details are noted and sorted and contrasts and comparisons are used in the attempt to clear up the meaning of the term.

The example which follows gives a model for this very important type of writing. Others will be found in the examples of paragraphs of definition in Chapter Six on the means of paragraph development.

EXAMPLE: DEFINITION[2]

A kilowatt-hour is that amount of electricity which will keep alight for an hour forty of the ordinary twenty-five-watt incandescent lamps, or one

[1] HARRISON, GEORGE RUSSELL, "More Precious than Rubies," *Harper's Magazine*, 175 (1050): 640, November, 1937. Used by permission of *Harper's Magazine*.

[2] GRAY, GEORGE W., "Full Steam Ahead," *Atlantic Monthly*, 159 (1), 118, January, 1937. Used by permission of *Atlantic Monthly*.

such lamp for forty hours. It is equivalent, in energy available for work, to one and one-third horsepower for an hour. And just as you can figure the cost of the horse's power in terms of food consumed, so you can reckon a kilowatt in terms of coal burned.

Problems

1. Describe (and use sketches to supplement description if needed): the laboratory suction filter; the sling psychrometer; a pair of pliers; a jack squib; a three-way switch; a screw jack; a spark plug; a lawn mower; a corn planter; a pair of skiis; an electric sweeper; an ice-cream dipper; a windshield wiper; the moldboard of a plow.

2. Give an account of the procedure for cutting a film for a miniature camera; installing an electric doorbell; making up the "dummy" for a magazine; enlarging a snapshot; drawing a book from the library; grinding valves; banding birds; erecting an antenna; preparing for a final examination; making out a time budget; cleaning and polishing a car.

3. Define sand, agronomy, differential, timer, cellophane, air-conditioning, Diesel engine, streamlined, plastics, capillarity (in soils), gravel, a combine, tugboat, dredge boat, a drill, tile, paint and varnish, refrigeration, slide rule, a transit, an analytical balance, a plane table, shale.

Chapter Eleven

The Report of Experience

THE IMPORTANCE OF PARTICIPATION

The facts of experience are derived from skillful personal action. The experienced person need not be an expert, but he must have sufficient practical ability to present his facts accurately. Consider the difference in personal action when one is driving an automobile and when one is sitting beside the driver. In the first instance, the driver's hands are on the wheel; his foot is on the accelerator; he peers ahead for traffic and intersections; he is responsible for progress, speed, and safety. The passenger, on the other hand, sees the driver shift gears, steer, watch the road; but the passenger has no active part in any aspect of driving. Participation is the distinguishing feature of experience.

The report on experience, perhaps the type most frequently required in professional practice, presupposes real effort in an activity. It is the account of skillful work in phases and details of a profession or an avocation. It relates what the writer has done in an industry, a laboratory, the field, the office, or the clinic. It records procedure which may serve as a model, or an example for those who may wish to apply it. An adequate account of an experience can be written only when the writer has had sufficient participation to be familiar with the essential details of procedure. He has worked in a steel plant, made an airplane model, set up a small chemical laboratory for himself, kept bees, raised poultry, or made a stamp collection. He has fashioned his own equipment and made it work. In college, he has performed experiments in chemistry, in physics, in botany, and in zoology for himself, instead of watching demonstrations.

The report on experience is concerned with what the writer has done, what equipment he has used, how it worked, and what has been the result. An account of the procedure for building an airplane

model, for instance, would include comment on the wood, parchment, glue, set of plans, construction, and assembly of parts. The manipulation of the machine produces something, or does something; combining materials results in something tangible and used. These points should be kept in mind by those students who wish to develop skill in writing reports on experience.

Experience may include, also, actual experimentation and original research in the laboratory. It may be a simple narration of a process; a procedure; a day's job from eight o'clock to five, five days a week. Or it may be a simple narration with some attempt at analysis of methods, conclusions on the significance of the activity, and recommendations for betterment and future action.

SELECTING THE EXPERIENCE

In practice writing, the first consideration for the report on experience must be the selection of work upon which the student is competent to write. It should be an account of some activity in which the writer has had a direct part. Most first-year students have not had experience in industry related to their future profession. It cannot be expected of them, and is not. However, experiences growing out of particular interests and hobbies offer excellent topics for practice report writing. The procedure is the same in both the practice report and the actual professional report on experience. Both must include enumeration of the facts and the explanation of the process or procedure, whether it has been the construction of a model or of an actual airplane. The facts, therefore, accumulated from experience in building an amateur sending set, from collecting stamps, from keeping bees, from learning a new skill such as running a lathe or using tools in manual training projects, even from sports such as fishing, hunting, sailing, shooting at a target, offer unlimited topics for practice in writing the experience report. In it, the purpose is to explain the steps that went into the building of the structure, or the progressive stages of the method of carrying on the activity. In a very real sense, this report on processes and procedures demands writing out of what the writer already knows. The emphasis in the present discussion, therefore, is upon the series of operations or progressive actions involved in performing an experiment or making a structure, and upon the methods of carrying on an operation or a process.

When the student writer is trying to determine what personal experiences lend themselves to matter-of-fact accounts of processes and procedures, he will find the following questions helpful:

What were the raw materials with which I worked?
What did I do with them?
What happened, and what was the result?

As soon as any experience is broken down into the actions that went into it, the details of the process or the procedure become apparent. The great difficulty is in getting sufficient perspective to recognize the significant units of materials, methods, and results. Further questions which will aid in focusing thought might be:

What was the purpose of my work?
How did I go about doing it?
What did I do first?
What did I do second?
How did the second action relate to the first?

A whole series of progressive questions can be worked out by which the writer can recall the entire process or procedure.

When the appropriate type of personal experience has been selected, the next specification is that it should be recent, or should have extended over a sufficiently long period to be thoroughly familiar. If it does not meet either of these requirements, significant details may be overlooked; yet, only with them can the account be clear, convincing, and accurate. It should reach down to the fundamental principles and the routine or the standard practice developing from practical individual skill. The writer, therefore, must be able to tell how the process has actually been performed. In other words, the writer of the report on personal experience must be, to some degree at least, an expert. Furthermore, in practice writing, it is best to select an experience which can be checked by observation, should there be need to verify some details that have become hazy with lapse of time. The experience, also, should hold some special interest for the writer because it has been successful or has challenged his thought and skill. Experience may not always solve problems. It may, instead, raise questions, stimulate thought, and actuate a desire to have further practice and to understand the underlying principles. Many a student has come to college, or has

returned to college, because his practical experience has challenged him, aroused his curiosity, and thus created a motive for more knowledge.

Some of the points which will aid in selecting the experience to use in a practice report are:

1. Choice of either *a* or *b*:
   a. What has been my most interesting recent experience?
   b. With what experience in making or doing something have I the most familiarity?
2. How long has this experience been in weeks, months, or years? (Whenever possible give the exact dates.)
3. If the experience has been in industry, choice of either *a* or *b*:
   a. What were my actual duties, and how were they related to the whole work?
   b. What were the details of organization if a project was concerned?
4. If the experience has been the result of amateur interest or a hobby: How did I go about the construction of a model?
5. What were the actual steps in making a piece of equipment or a structure from a pattern or a set of plans?
6. What were the steps in transforming raw materials into a finished product? What machines were used? How did they operate?
7. How did I begin my collection, *i.e.*, what materials were required at the start? As the collection was extended?
8. What are the steps in a game or similar activity?
9. In writing up this experience, could I make use of any sketches, diagrams, photographs to supplement my written presentation?
10. What has been the result of this experience?

Some of these questions, it is true, overlap those given on page 166. They have been repeated because they will be seen in relation to the whole procedure of determining the topic which can be adequately treated by a competent writer. Questions 4 to 8, inclusive, will be considered in some of the later outlines under the general head of *procedure*. For the purposes of the first analysis, however, these have been broken down into questions that would cover particular types of experience. Obviously, the writer considering a possible topic must determine which of these questions concerning procedure apply in a particular case.

In actual writing, the answers to some of the questions must be combined in one paragraph. The replies to Questions 1 and 2, for

instance, quite naturally go together in the opening sentence, or even in the title. (See the title of "Working in the Bay High School Library," page 172.) The answer to Question 10, of course, does not belong in the actual account of the process or procedure; but *results* should always be considered, in order to see the significance of the experience to the writer's thought and life. They give perspective on the activity. The comment on results in the practice report of the student is often placed in the letter of transmittal to the instructor instead of the concluding paragraph of the report on experience. The concluding one here would be a generalization as to the final effectiveness of process or procedure.

Yet, in spite of the fact that these questions must often be modified, or some of them even omitted, the answers will indicate to the student how well qualified he is to discuss the work or the skill that furnishes the facts for an experience report. At times, he finds telling difficult, for he feels that others know what he does and that routine work holds little of interest to them. For the man who both knows and loves his work, however, there is always something interesting in the activity to which he has given his thought, energy, enthusiasm, and time. In fact, the interest to himself, as well as to others, comes often from discovering new dimensions to familiar things or in setting tangible boundaries to routine work. Thus, standard practice emerges from rambling memories.

Simple and unpretentious experiences should not be overlooked by students when they are casting around for topics that will work up into practice reports. The accounts of hobbies, such as building models, collecting stamps, raising chickens, growing a crop, planting a garden, membership in a musical organization—a band, an orchestra, a chorus—activity connected with 4-H Club membership or with the Boy Scouts, as well as commercial or industrial experiences, are worth considering. The main requirement for any experience report is important enough to repeat: *The facts must be the outcome of the writer's participation in the work that he reports.*

MAKING UP THE NOTES

After a suitable topic has been determined, the next step in preparing an experience report is to make the notes and directive outline for the initial assembly of the material. The general principles involved have already been discussed under the outline in Chapter Four.

Here, again, answers to a series of questions will suggest the contents and the order of the first outline:

1. What do I want this report to do? In other words, what is the purpose, or the object, of this report? (While it is enough in this first attempt to phrase the object rather loosely, the writer should take time at this point to put it into a *complete sentence.* A positive statement gives the purpose direction as well as limitation.)
2. What materials, equipment, layout must be noted for later description? (In outlines for professional reports, this heading is designated as *description* of apparatus.)
3. What are the necessary steps in the account of the process or the procedure, *i.e.*, how does the apparatus work? (These have been covered by Questions 4 to 8, inclusive, of the topic-finding group of questions, page (167), but are repeated here in their proper setting.)
4. What have been the most interesting features? The most important? The most difficult? (These would come under the head of *discussion* in a professional report.)
5. What has been the net result of the work and of the experience? Is its value in getting information and ideas for future professional use, for skill in doing, for general knowledge?
6. What changes should be made if the experience were to be repeated? (Questions 5 and 6 make for *results* and *conclusions.*)

Again, there is some duplication in the questions for discovering the topic and the method of preparing the report. In the first instance, the answers should bring out the points to be used; in the second, these points are being developed.

Answers to these questions might well take the form of notes or a memorandum jotted down as the writer, unhampered by any need to put his thoughts in coherent, extended form, considers the material that he will finally include. It is more easy, obviously, to sort, reject, retain, and assemble ideas when they are in the component parts that will later go into the coherent whole than to tear down and rebuild the whole. Consider again, the help that outlining gives to writing. From the outline, the topic can be seen as a whole—from the beginning to the end—and the details can be sorted and arranged in the most effective order. As a result, the final draft becomes comparatively easy, for with the ideas ready, the writing becomes a matter of assembly—of following a set of plans, just as in assembling a model from a blueprint.

The examples which follow suggest possible procedure for choosing a topic from some of the types of experience which a first-year college student may be expected to have. He can, of course, use the form that he finds most pertinent. First, there is a type of informal experience neither commercial nor industrial. It can be illustrated by "My Work in a Large High School Library." It is phrased in the assignment as a general topic which the student writer will have to modify to make personal. To determine his qualifications for writing on this topic he will select from the questions for choosing a topic, page 167, those which are applicable. In the case of this particular subject, the following will be checked:

1. Most recent interesting experience.
2. Extent of experience.
3. Actual duties and details of organization.
9. Graphic presentation.
10. Results of the experience.

The other questions do not apply in considering this particular type of experience, because the account will deal with personal handling of the books by the writer, and the organization concerned therewith, not with the product of an inanimate machine, or with construction, or with the collection of materials, or with the playing of games.

Selecting the most interesting recent experience should stimulate thinking. By considering *extent*, the writer should discover whether he has sufficient knowledge to speak authoritatively. Detailed account of duties will demonstrate the extent. In experience, observation, and inspection, the *extent* of familiarity should always be noted. It is the writer's factor of safety, for it justifies omissions and seeming lack of thoroughness, as well as indicates to the reader what he can expect. For instance, after the writer has worked in the library for a year, he can be expected to give more details of library procedure than he would if he had written an account after spending but three hours in a library, visiting the loan desk, the reading room, the stacks, and seeing the activities associated with them.

If personal information is inserted under each of the five divisions which cover the writer's account of working in a library, the following notes might result:

1. Most interesting experience: Library work, Bay High School, Senior year, 1937–1938.

The account of the experience

2. Extent of experience: Sept. to June; 10 months, 5 days a week; av. 3 hours a day.
3. Actual duties: To get books from the stacks at the direction of the librarian; to keep tables in reading room clear; to return books to the stacks. Detailed comment on organization of the library is unnecessary. Whatever is needed in connection with this topic will be put in naturally under Heading X, Results.

Graphic illustrative material

9. Graphic presentation: Sketches of library floor plan showing location of loan and reference desks, of the stacks, and the arrangement of tables in the reading room.

Letter of transmittal

10. Results of experience: I learned library methods and the classification of material of all sorts. I had experience in meeting people.

An advantage of an experience such as this for a practice report is that, if the writer needs to refresh his memory, the procedure can be checked with that of the college library. He should not depend upon reading up on general procedure if he feels that he must have help in recalling a few hazy details of an experience. Rather, he should seek out a similar activity close at hand and inspect it. Thus he will review the whole procedure much more vividly than by reading. Besides, in a practice report on experience, the great value comes from the attempt to relate what the writer actually had a part in doing, not what he has heard or read about it. This last comment is not meant to minimize the value and help that reading to review a subject will give, or the need at times to go to books for knowledge of the underlying scientific principles in a process or a procedure. Few can expect to have this information from personal experience. Generally speaking, however, the student who wants to become a skilled writer of reports of experience will not want to lean upon the plan and discussion of others. He will take the opportunity to discover how much personal knowledge he has to assemble.

OUTLINING

From the notes on "Working in the Bay High School Library," a first draft outline in which the general one on page 169 serves as a guide might result in the following:

TITLE: WORKING IN BAY HIGH SCHOOL LIBRARY, SEPTEMBER TO JUNE, 1937–1938

1. *Object:* The purpose of this report is to give an account of my experience in the Bay High School Library that will show how books for circulation and for reference are handled.
2. *Description:* Card catalogue, stack arrangement, request slips, record card. (Sample cards to illustrate.)
3. *Procedure:* Give a brief account of the method of getting a book for reading in the reference room. Take as example a request for information to be found in an encyclopedia. Describe also getting a book for home use such as Emerson's *Essays*.
4. *Discussion:* Most interesting features of the work: the different pupils and the books they asked for. For instance, one boy always wanted books on aviation; one girl spent all her spare time reading on costume design.
   Most important feature: Having the call number, the author, and the title accurate.
   Most difficult: Learning the classification and the location of the books in the stacks, and refusing pupils when they were not eligible to have books.

As this has been a simple account of experience, it is complete when the items under Heading 4 have been adequately discussed. Results and changes are often added because of their implications and effect upon the writer. In this instance, they belong in the letter of transmittal, where they justify the choice of the particular experience for the report. Notes for these two headings might be the following:

5. *Results:* Learned library procedure and classification of printed matter of all sorts—books, periodicals, pamphlets, etc.
   Had experience in meeting people.
   Can get good grades in any college course requiring the use of the library.
6. *Changes:* Would learn more about the reference books pertaining to the applied sciences.

Each series of questions used with the topic, "Working in the Bay High School Library," it will be noted, has been a step toward the development of the complete report. The headings have been fixed in the topic-finding series. They have been amplified in the succeed-

ing ones until the writer knows what he had in mind when he decided that the most recent experience upon which he was competent to report was his work assisting in the high school library in his senior year. After he has deepened his thought on these main topics by use of the content-finding series and has extended them to his satisfaction, he is ready to go about writing the first draft of his complete report.

Before this procedure is given, however, consideration should be devoted to types of experiences requiring the use of other questions of the series, or modification of those that developed the report on work in the high school library. In discovering the facts for an account of stamp collecting, which represents a less formal activity than working in the library, the topic-finding questions follow in the main those used for the library experience. In an account of stamp collecting the following questions (page 167) will be checked:

1. *b.* A familiar experience.
2. Extent of experience.
7. How the collection began and how was it extended.
9. Graphic presentation.
10. Results of this interest.

Personal information inserted under these findings might result in:

1. A familiar experience: Stamp collecting.
2. Extent: The past four years.
7. The start: The commemorative stamps of the Century of Progress Exposition, Chicago, 1933.
   The methods of collection: Gifts from friends, exchanges with other enthusiasts, purchases from dealers.
9. Graphic presentation: A page of specimens.
10. Results: An interesting hobby, an increased knowledge of history and geography.

From these notes, a first draft outline might include:

TITLE: MY EXPERIENCE IN STAMP COLLECTING

1. *Object:* The object of this report is to tell anyone who wants to become a stamp collector how to proceed.
2. *Extent:* The past four years.
3. *Procedure: a.* A brief account of what aroused my interest; my first stamps.
   b. Methods of collecting.

4. *Discussion:* Most interesting feature: Finding a rare stamp in a package purchased at a stamp auction.
   Most important feature: Knowledge of common, rare, and new issues.
   Most difficult feature: Financing purchase of new ones; keeping informed on new issues.
5. *Results:* An interesting hobby, widening my acquaintance with others in the United States with similar interest; an increased knowledge of geography, history, and contemporary events.

These examples are typical enough of varying activities to suggest to the student writer how to proceed on his own initiative to build up an account of an experience.

ESTIMATING THE LENGTH

Attention thus far has been centered upon the means of selecting and tentatively working through an experience so that the body of facts will emerge. Even after a writer has discovered what they are, he still has the problem of getting out a finished report.

Before the actual writing begins, however, several questions arise: First of all, what determines the length? Then, how can a report be given length? Next, what forms of writing are required in the several parts? Finally, how are the units of composition used? The main divisions and the principal subdivisions of the content outline, arranged in a coherent form, will make a discussion of some 500 words. But how is a writer to get the 700 to 1000 more that are necessary when a 1200- to 1500-word report is assigned? The limitation of a discussion by specifying the approximate number of words it shall contain is helpful in indicating what will be an adequate presentation, just as five minutes or ten minutes suggest to the speaker the amount of time allotted him. Word limitation, however, is not the most important means of setting the length of any piece of writing.

An extended experience does not necessarily make a long report. Length depends upon the number of details inserted. These, in turn, are determined by the intended use of the report. If the reader wants information in order to perform the same work, *i.e.*, instructions in the basic procedure, then extended detail can be omitted. He needs only sufficient to enable him to advance from one step to the next. If, on the other hand, the reader wishes to know just exactly the range of the writer's experience—his actual duties,

the materials with which he worked, the procedure—then the report must be extensive. It must show, not only that the writer knows how the work is done, but also that he is familiar with the underlying principles, the significance of his work, and the adaptation of the scientific principles. It must be such an account of his participation that the reader can, figuratively speaking, see him at work. Such is the kind of report that students are required to submit after some practical experience in summer vacation periods. The technical instructor wishes to see, as it were, the student working, demonstrating his skill, his reliability, his cooperation, and his alertness to modifications in theory which actual practice necessitates.

The Sections.—If length is secured by the amount of details incorporated in an experience report, what sections should be expanded, *i.e.*, what are the natural places where development should come? In the statement of the object? Description of apparatus? Account of procedure? Discussion? Results? In most student reports, the object can usually be stated in one concise sentence—at most, in five. Results, *i.e.*, conclusions, can also be put in a few carefully worded statements. The number will depend upon the problem which the report has solved. In the reports of the first two years in college, amplification should come mostly in description of apparatus and account of procedure, for students must demonstrate in these laboratory reports that they can describe apparatus and tell how it works. Discussion increases as the student progresses in his professional studies.

Daily familiarity with a process or procedure is likely to dull a worker's awareness of the items that make up each step; yet, just as the motion-picture camera may give a slow-motion picture of the pole vaulter approaching, clearing the bar, and descending, so the writer may take apart the total impression of the essential details of his content outline and show the items that go to make a unit of a process or procedure. Depending upon the reader, the writer has always the problem of selecting adequate facts. If the reader is a beginner and needs to know at the start only the indispensable materials and method, he has to be given at the outset as few as possible. Take as an example the boy who is learning to pitch in baseball. At first, he is interested and can be expected to try only to pitch the ball over the plate. He makes few attempts to put in curves. As he becomes increasingly expert, he takes straightforward pitching

for granted, and gives his attention to developing his peculiar style. The ball will still get over the plate but, in addition, will fool the batter. If his coach in the beginning, however, had gone into great detail on the peculiarities, and differences, he would only have confused the unskilled pitcher who had no experience upon which to base judgment. The coach at first, therefore, presented only the basic principles and procedures. The writer should use the same simplification in instructions when he selects the features of a process or procedure for the beginner or for the uninformed reader.

ARRANGING THE TOPICS

After the proportions of development for each division have been decided and the requisite length has been estimated, the next point to be settled is the order for the development of the finished report. Shall it be a time arrangement—first day, second day? From raw material to finished product? From simple to complex? There are, of course, other arrangements. The mastery of these three, however, will give sufficient skill to use the others acceptably when they are required.

Time Order.—The easiest and most natural order of development is the chronological, *i.e.*, recording the actions in the order of time. By this means, the writer can see the work along the whole assembly line—the beginning, the intermediate stages, the conclusion. This time order is the best to use for the first plan of any experience report. Thus, the writer can review his work day by day. Though this day-by-day record is excellent when sizing up work and discovering fundamental principles, it cannot be carried to extremes in writing. Space will not permit; needless repetition would result. In the finished report, only enough of the daily routine should be recounted to show how it is typical of all days.

A modified time order may be used when the experience is considered in periods, rather than in days. For instance, in the beginning period the worker is conscious of every move he makes and of his lack of skill; then he reaches the period when he performs his task with less conscious effort and more skill. Finally, he becomes a skilled worker—an expert who can demonstrate to others or judge how the work is done. When he reaches this last period, he can separate the basic operations from the variables. Any experience, therefore, might be divided into (1) the beginning period, (2) the

intermediate, (3) the expert. These three main headings, chiefly concerned with the general procedure, would furnish enough facts for a 1200- to 1500-word report.

Another convenient time order is worked out by subdividing the experience according to the calendar. Often, units of experiences such as those suggested in the previous paragraph can be combined with the calendar. This resulting order, for want of a better name, might be called semi-calendar. For instance, in an account of the experience in the high school library, the development might be grouped under:

1. Experience at the opening of school in September.
2. Experience before examinations, of which that in January would be typical.
3. Experience at the close of the school year in June.

The use of such divisions indicates the combination of two methods. While this arrangement is not literally week by week, or month by month, it does divide a full period into significant chronological units.

Progress Order.—A second method of presentation is to follow the work through departments toward the development of the finished product. These impersonal discussions of processes and procedures are frequently records of the changes that raw material undergoes on the way to becoming the finished product. Here, too, the general divisions are the natural ones: raw material; machinery for manufacture; manufacturing process; finished product. The reverse order, from the finished product back to the beginnings, and raw materials, is sometimes used. With the finished product before him, the writer looks back and points out all the processes and the effort that are bound up in its production. He sees below the surface and knows what the product represents. The usual order, however, is from raw materials to finished product—whether it be a piece of equipment or a tall building or a dam.

Known-to-the-unknown Order.—A third possible method—one requiring more insight and writing skill than a beginner can be expected to have—is to proceed from the known to the unknown. The skilled writer employs this plan when he wants to make his account clear and vivid to nontechnical but interested readers. In popular accounts of science, such authors as William Beebe, William

McFee, Edwin Slosson, Charles W. Gray, have often used this order to explain in simple, vivid terms interesting and significant aspects of various sciences to the lay reader. Examples of this order may be found in the newspapers and the widely circulated weekly and monthly magazines. It frequently requires a more detached point of view toward the material, more recognition of the reader's lack of knowledge, and more selection of details to make the account accurate, clear, and vivid, than are usual in writing on scientific subjects. More extended use of this method in report writing would make for better presentation generally. While students do not often attempt this order, they would do well to know it, to find examples in current reading, and to make at least a few attempts to work it out. It is a great aid in developing a detached point of view, as well as in thoroughly appreciating the requirements of reader adaptation.

ASSEMBLING

With the topic selected, the contents determined, the proportions decided, the several items chosen and assembled, and the plan of procedure settled, the organization of the various parts into the complete, coherent account—the whole composition—is a relatively simple matter. The assembly is comparable to that used in putting together the different parts of any structure, each of which has been separately made but must be attached at its proper place and in its proper sequence, if a finished workable piece of construction is to result. Before this task is undertaken, however, the discussion of the first and final drafts of the whole composition, Chapters Six and Seven, should be reviewed, to see how the general principles of writing are applicable to this particular writing problem.

QUESTIONS OF STYLE

First or Third Person?—Then, there is one last question to be answered before the write-up: Shall the report be written in the first or the third person? In the active or the passive voice? Either may be used. The narrator may write, "I performed this experiment October 15," or "This experiment was performed on October 15." In the first phrasing, the reader is conscious of the writer performing the experiment; in the second, the experiment is the important item; the performer, unimportant. The first-person, active-voice presentation is often more simple and more natural, for the writer sees him-

self again doing the works and "feels" his participation. The disadvantage is that the writer may lose his sense of proportion and not distinguish between the essential and the nonessential; thus, interesting, conspicuous details sometimes get a disproportionate share of attention, and the whole report will be "out of plumb."

Passive voice is preferable in most scientific writing, for the activity, not the performer, is the major interest. Indeed, every professional report is expected to be as unbiased as is humanly possible. The personal element of the report comes in the letter of transmittal. Here "I" and the active voice can and should be used. However, "I" should seldom appear in the body of the report. Until a student becomes skilled in report writing, it will not be bad practice to write the first draft in the first person, active voice; then, in the final draft change to the impersonal passive voice.

An experience report, in most instances, represents the recollections of the activity by sensing the high point of the routine. They are those aspects of an activity which are inherent, regardless of whether it is carried on in one location or another, or by one person or another. These aspects would go into instructions for the process or procedure. They may be discovered by noting the work from day to day until, finally, the "pattern" of the activity will emerge.

The *words* used in the finished report, like the selection of details, depend upon the reader's knowledge. For the technical person, certain details are taken for granted, more details on special aspects can be included, and shop or trade terms can be introduced. For the nontechnical reader, the whole account must be simplified, with shop or trade terms that cannot be avoided, explained, and specialized aspects excluded.

GRAPHIC AIDS

In the answers to both the topic and the content-finding questions, consideration has always been given to possible graphic presentation that might supplement the written. Sketches of layout, of design, sample records, data sheets, flow sheets, photographs—all are excellent aids to clearness and vividness. But no matter how fine they may be as drawings or photographs, they should not be used unless they are an indispensable part of the presentation. While this point has already been noted in the extended discussion of Chapter Seven, it may well be repeated here.

MECHANICAL SETUP

The setup of the report on experience follows in the main the usual specifications for the cover, title page, table of contents, letter of transmittal. There are some items of this letter that should always be considered. To be adequate, the letter of transmittal for this report should include:

1. Statement of the subject and the authorization.
2. Statement of the experience in the field:
   a. If industrial or business experience, indicate amount of work done (days, weeks, etc.); dates of employment; department in which employed; and particular work done in that department.
   b. If a hobby, indicate extent of time it has been pursued and the amount of time spent in design or assembly of the work described.

3. Some comment on the results of the experience and on changes, were the work to be repeated. These are the two points of the topic-finding and method-finding outlines which have been already suggested for inclusion in the letter of transmittal. They come rather naturally here as a part of the reason for the selection of the particular experience for the simple written account. In a professional report, they become conclusions and recommendations. Here they often go also in the letter of transmittal, to make them easily accessible to the reader who expects to depend upon the writer for the interpretation of the facts and the suggestions for his course of action.

4. Statement of present source of information. The writer must explain how he has reviewed the facts of his experience. It may be by revisiting a plant, looking over his collection again, examining his model.

5. Statement of the plan of presentation, the point of view, and the limitations necessary for reader adaptation.

6. Acknowledgment of aid from those who have assisted, especially members of the drawing department. Notation of sources of illustrations, drawings, or any other graphic material. (If some brief digest of the theory, or history of the process is necessary, a footnote in the appropriate place in the body of the paper should be used, as well as comment on justification in the letter of transmittal.)

7. Generalization as to the result of the whole paper. This generalization should be largely comment upon the writer's feeling as to the success of his paper, and the benefits he has received from writing up his experience. A courteous final sentence may or may not be used. If used, however, it should be concise, sincere, and convincing. A courteous tone throughout would be even better.

ETHICAL QUESTIONS

When experience in industry is written up, confidential material must not be revealed. The writer must ask permission to use sample records and the like; he must make fair statements; he must make acknowledgments for borrowed material. After facts have once been put into black and white, they are out of control of the writer. He cannot withdraw his statements. Good ethics requires that, before the paper is released, even if it be only a practice theme, the final account of the experience shall be shown to some responsible person in the organization for his sanction. If this cannot be done in a personal conference, then the student should write a letter to a person in authority in the company. In this letter he should state his project, his proposed use of information obtained while in their employ, and his intention of acknowledging permission. He can never do wrong in telling his past employer what use he is planning to make of the information gained while working for him. Serious misunderstanding, as well as embarrassment, is thus avoided.

ADVANCED EXPERIENCE REPORTS

In college the experience report is usually required after summer experience or its equivalent in industrial or commercial work, especially between the second and third, and third and fourth years. In the first, the student is asked to write for his professional instructor an account of the processes that are used. The educational object of this report is to demonstrate to the instructor that the student has recognized and become familiar with practical applications of the appropriate scientific theories which underlie the work. This report is largely just an account of the development of the process. It differs from the practice report on experience for English in that the student in his summer-experience report is expected to supplement the account of the processes of which he has first-hand knowledge through participation, with some account of the other related processes that go into the manufacture of a product. These have been learned through observing them on visits to other parts of the plant, and by asking questions. This section in an experience report, the result of observation rather than participation, is specified in the summer-experience report so that the student may see the process as a whole. Thus, the report becomes a combination of observation and

experience, with the emphasis on experience. In the report between the third and fourth years, as a part of the report on experience, the student is usually asked to make some attempt at analysis and interpretation of the procedure and the conditions of the work. Outlines are frequently given to guide him in his discussion. If he is fortunate enough to have such help, he should be able to improve in the time at his disposal the quality and the directness of the presentation. He knows what the instructor wants. If he has to proceed upon his own initiative, the suggestions that he has had for the experience report in English are helpful.

In active practice, the report of experience is the expert's account of his method of solving his technical problem. It is his record of the professional activity in which he has taken an active part. It is often the basis of professional articles for technical journals. Here, experts recount their practice and experience in interesting and needful phases of their work. Reference to the appropriate professional journals will reveal to what extent experience is the subject of the technical articles.

WRITING FROM ACTUAL EXPERIENCE

The report on experience, it cannot be too strongly emphasized, must demonstrate that the writer actually knows what he is talking about because he has performed the work. A good understanding of the specifications of an experience report is important. Through experience grounded upon scientific information and analysis come expertness and leadership. There is no real substitute for actual experience. A competent foreman has usually risen through practical experience, or is given an opportunity for it before he is put over other men. He makes a convincing leader because he has participated at some time in the work.

With knowledge from experience, one can increase the accuracy of his observation, the insight of his inspection, and the penetrating analysis of his research. Reports of technical experience should always be accounts of what the writer knows *as a participant*. He can never expect to get it secondhand. Observation and inspection involve the writer to a much less degree. The test of an experience report is whether it is so clear and simple that the reader will be able to do the work, or whether it is so clear and detailed that the reader will be able to see the writer working. Perspective on experience is of

value, also, in that it gives a norm, a pattern, a bench mark, a calibrating instrument, or a standard of comparison out of actual participation. It is a very necessary basis for authoritative reports on observation and inspection.

There is no better admonition for the writer of the experience report than this: Give a clear, accurate account of what you did; what you worked with; how you did it; and what it was for. Stick to the facts; make notes on what you remember of the process or procedure. Don't attempt at first to work out the final order; find your related facts as they are suggested by your activities—as many as you can; then, sort them and assemble them so as to check whether they will clearly represent the work and your part in it. Finally, rearrange these facts so that they will meet the need of your reader, as instructions or as demonstration of your skill, performance, and insight.

Writing about experience should be "just writing about what you know." Because this is often familiar, everyday experience, it is difficult to get perspective. The writer assumes that everyone else knows as much as he does about it. If he is competent to write a good experience report, he will find that he can set down more details than he can use. If, however, he has laboriously to draw, not only every detail, but also every word that he includes, either he has insufficient experience, or he has not reviewed it thoroughly before starting to write. If he is familiar with his subject through first-hand knowledge, *i.e.*, through some degree of actual manipulation, he will find that his writing problem becomes one of getting perspective and of selecting and writing up the salient details for a particular reader and a definite purpose.

The selection which follows, entitled *Pinhole Photography*—a straighforward account of experience—will furnish a model, both as to plan and length, for the student in writing up experiences involving processes and procedures. Note that while it is not designated as a report, it has all the divisions of a report—object, description of apparatus, method, discussion, and results.

EXAMPLE: REPORT ON EXPERIENCE[1]

Wishing to take some views in my sister's garden, especially some showing as much as possible of the house and grounds, I found that my 8½-inch

[1] HEYSER, CHARLES A., "Pinhole Photography," *The American Annual of Photography*, 51: 249–250, 1937. Used by permission of American Photographic Publishing Co.

lens would not do what I wanted, as it covered only about 53 degrees on the 5 by 7 plate. Then I thought of taking the views through a pinhole, which, I knew, would give as wide an angle as desired, without distortion, and with no other fault than, perhaps, too violent a perspective, which would have resulted, anyhow, had I used a wide-angle lens. As to critical definition, I counted on its absence contributing toward a more artistic effect, and in this I was not disappointed. Though soft, the definition was surprisingly sharp, and the negatives of excellent quality, without a trace of fog. I have no doubt that they could be enlarged to 8 by 10, and still give satisfactory definition for artistic effects. As to the prints, though I may be mistaken, they seem to possess a luminosity different from that given by a lens, possibly due to the action of the ultraviolet rays, which are absorbed by glass.

Previously I had, at one time or another, experimented with pinholes, both on paper and metal, but with no results worth mentioning, the negatives showing a great deal of fog and "fuzziness"; so this time I resolved to realize, as much as possible, the conditions for an ideal pinhole. Here it may be asked, What is an ideal pinhole? Theoretically, it is a small aperture, having absolutely clean edges, in an opaque plate having no thickness, and of a diameter calculated for a given wave length, or color.

Obviously, these conditions are hard to approximate in practice, especially if one works with black paper, which, if sufficiently free from microscopic openings, has an appreciable thickness when compared with the small size of the pinhole, and contains fibers which, while not visible when just finished, may later stick out from the edges, or lodge there as dust difficult to remove when in the field.

Some writers suggest sealing a paper pinhole with Canada balsam between two pieces of thin glass, such as are used for covers of microscope slides; but the time and care involved are not less than in drilling a metal plate, and one has, at best, a frail thing to be kept scrupulously clean and safely stored away. Also, the absorption of actinic rays by the glass makes the pinhole much slower, and this, when the "speed" of an unobstructed aperture is measured in minutes, not seconds, is important.

On the other hand, the metal instrument has these advantages: The ideal conditions I mentioned are more fully realized, as, by following my method, the opening will be perfectly regular, and its edges will have no thickness, in the sense that a razor edge has none. Once made and proven good, it will render a life-time of splendid service. It need be no larger than a dime and it will be quite as strong, requiring no more care than a coin in your pocket. And, most important, your negatives will be sharp enough to withstand moderate enlargement, quick printing and be free from fog.

Although, by careful examination on the ground glass, there does not seem to be much difference in definition between images given by the same

pinhole working at different distances from the plate, it is considered that for a given size of opening there is a distance at which the definition is sharpest. These sizes of openings are called the Watkins-Power numbers and are used in calculating exposures. The rule is easy to remember: Multiply the W. P. number of the opening by its working distance from the plate. Use this result as the *f* number in any exposure meter or table, and read the exposure as *minutes* or fractions of a minute. Thus, W. P. 6 at 8 inches; calculate as *f*:48. If the tables call for one second, expose one minute.

Coming now to the construction of a metal pinhole, I will first tabulate these W. P. numbers as suitable for use in 5 by 7 or smaller cameras.

W. P. No.	*Diameter*	*Needle size*	*Distance*
6	0.027″	7	10″
7	0.023″	8	8″
8	0.020″	10	5″

Having decided on what size of opening you want to use, procure a piece of thin brass, which metal is recommended, as it is easy to work and will not rust. The top or bottom of a small "compact" box has the right thickness and is excellent for the purpose. The sides can be removed by filing all around the edges until thin enough to be broken off and the rough edges removed. Procure also a suitable needle, a strong magnifier, a small oilstone, some black paper, glue and India ink.

Sharpen the small blade of your penknife to an obtuse V shape, so that it will drill, or rather ream, a conical hole much wider at the top than at the bottom. It is this conical shape that gives the pinhole its most important part, *i.e.*, its knife edge. Set the plate flat on the table, and, holding the knife vertically over the surface, turn it round and round with the fingers, exerting only a light pressure, so that the little cavity which, when finished, will be about the size of a pin's head, will be perfectly round, and its sloping walls quite smooth. This is the slowest and most important part of the process, for success will depend on its precision, and especially is this true toward the end, when the knife must work with almost no more pressure than its own weight. Use the magnifier at frequent intervals, and examine the back of the plate. Little by little a small raised spot will appear directly under the cavity on the other side, showing that the metal is getting so thin that a light pressure with the needle might break it.

This is the moment to stop drilling. The opening is started, not with the needle, but by grinding down with the oilstone. As soon as the smallest opening appears by holding the plate up to the light, insert the *point* of the needle *from the front* lightly turning it round with the fingers;

then again use the stone on the back. These operations are repeated in the same order, the needle being pushed in from the front a little farther each time until its length passes through, when the pinhole is finished.

It only remains to cover the back of the plate with black paper, in which an opening a little larger than the pinhole has been cut, so that no fibers shall cross its field, and finally this bare spot is blackened with India ink, also putting a droplet in the cavity, where it is left to dry by itself. If the work has been carefully done, the magnifier will not show any thickness at the edge, reflections or bare metal, and you will have as perfect an instrument as it is possible to make.

As to its mounting on the camera front, any method is good, as long as no light filters in around it. However, if mounted as a cap to fit the lens barrel, this may cut off the light when a wide angle of view is desired. It is much better to have an extra lens board, which can be easily made of heavy cardboard. Then one can make a shutter without much difficulty, and if, as some writers suggest, a filter is used with color sensitive plates, an extra opening can be cut, and a gelatin filter glued under it.

I hope that readers who have used pinholes with indifferent success will now try this method of making a perfect instrument, as many unusual effects are possible with extreme wide angles, and many subjects, unattractive when taken at close quarters with a lens, may prove fascinating when shown as a whole.

Problems

Topics for reports on experience.

1. Playing baseball, basketball, football, hockey, tennis, skiing.
2. Working on a school annual or a school paper.
3. Collecting stamps, old coins, butterflies, ferns, arrowheads.
4. The duties of a caddy, a newspaper carrier, a clerk, a waiter, a messenger, a filling station attendant, a demonstrator, an attendant in a clinic.
5. Building models of airplanes, ships, locomotives.
6. How to organize a band, an orchestra, or a drum corps.
7. Procedure for observing birds; for identifying native wild flowers.
8. Directions for the care of an orchard, for making camp, for setting up an exhibit at the fair, for arranging a flower show, for exhibiting livestock, for making camp, for transplanting trees, for planting bulbs.
9. Growing corn, wheat, tobacco, vegetables, flowers, small fruit.
10. Handling cattle, training hunting dogs or fox hounds, breaking colts, raising chickens.
11. Building a garage, a farm structure, a sailboat, a glider, a battery brooder.
12. Sailing, fishing, touring, target shooting, hunting, trapping, flying.

13. Necessary equipment for fishing, hunting, playing golf, baseball, camping, touring.

14. How to arrange stage lighting; to construct a stage set.

15. Making a rock garden, cuts for a newspaper, a good photograph, puppets.

16. Directions for keeping an automobile in good condition.

Additional topics will be found in Problems for factual narration, Chapter Ten, p. (163), and for observations and notes, Chapter Three, p. (36).

Chapter Twelve

The Report on Observation

PHOTOGRAPHIC WRITING

The facts of the observation report are derived from seeing things with scientific perspective. In method of acquiring information and in results, this report and photography have many points in common. Through the medium of words, instead of the action of light upon chemically prepared surfaces, the observer tries to record scenes and objects as faithfully and as accurately as the photographer. The observation report is concerned with the visible features and manifestations of an activity, a process, or a project. It demands the "seeing eye."

More than either the experience report, which records the facts learned through actual participation, or the research report, which records the facts accumulated by men of all ages and countries, the observation report records data caught at a particular time under conditions obtaining at the moment. The same object, or the same project, even though it is permanently placed, will present to the observer different aspects from different locations, on different days, at different seasons, and under different circumstances. For instance, take the facts recorded from observing a storage dam at flood stage, at drought stage, and at ordinary water level; or the stages in the construction of a storage dam—the view of the river and the banks at the site, the clearing of the site, the assembling of materials and equipment, the appearance at the various stages of progress, the finished structure. Each condition or stage has a distinct group of facts; these give separate "photographs." Each may be a complete report or, combined and assembled in their proper sequence, record extended observation. So important are momentary influences—the season, the prevailing weather conditions, even the time of day—that they must always be noted, for they are pertinent facts in reporting an observation. The amount of time, too, spent in gathering the

facts—an hour, a half hour, a day, a week—has significance, as it affects the conclusion that can be drawn from the observed data.

The observation report, therefore, is a record and an interpretation of exact physical and visible conditions of an applied science project. It depicts either units of obvious progress on a project or single conditions, just as do photographs. It may require movement and travel on the part of the observer. He may take snapshots, time exposures, or slow-motion pictures. The distinctive feature is that the unit scenes are so complete in themselves that each one can be individually identified. This is exemplified in a series of photographs showing the development of hydroelectric power:

1. Water: a mountain waterfall, two dams. (3 photographs)
2. Production: opening by-pass to fill water wheels, the generators, the huge shafts, the switchboards, the transformers. (5 photographs)
3. Consumption: use on the farm, in the home, in industry. (3 photographs)
4. Flood control: A swollen stream in the valley. (1 photograph)

Reports by photographs can, at times, be substituted for an observation report in words. Thus, the telephotographs of the newspapers present in a series of pictures, transmitted by wire, the first observations of a destructive tornado, a devastating flood, heavy snows, and damaging frosts on highways—all taken when those particular conditions prevailed. Later, written accounts accompanied by more photographs may be added for detail; but they are not substitutes. Judgment is, of course, necessary to decide when to use words and when to dispense with them and let photographs tell the facts. In any detailed observation report, the two methods are combined. The interested student has only to refer to a report on observation of any applied science project in any technical journal or bulletin to see illustrated the two methods in combination. But whether words alone or words supplemented by photographs are the media for recording the data in an observation report, the facts are always gathered through the reporter's actually seeing the details of the particular project. He cannot get them by reading or by hearing about them, any more than he can take a picture of a scene without being on the site with his camera.

DEFINING THE PURPOSE

To help the observer put his facts into as vivid and accurate a form as the photographer gets from his camera, there are methods of writing up observations. First, there is defining the purpose. It must be sharply defined, because of the necessity of observing conspicuous and significant points, usually in a very brief time, and often with no chance to see them again. The casual, superficial observer has no particular use for the facts which haphazardly come into his line of vision. He is, therefore, unselective and gives attention to those features that are conspicuous. He is open-minded, not through scientific detachment, but through lack of definite purpose.

The scientific observer, on the other hand, has a particular purpose in gathering his facts. He is selective and, with some knowledge of the underlying scientific principles involved and a detached point of view, goes about his observations. By picking out the salient features, finding relationships, and keeping his sense of proportion, he aims at evaluating the facts of the particular project, process, or activity, and at reaching accurate conclusions. While his mind is as open to what he looks at as that of the casual observer, his training and his purpose give direction, boundaries, and significance to the facts that appear before him.

Numerous examples could be cited that bring out this marked difference in point of view, training, and purpose when the same object is under consideration. Take, for instance, the differences in what the casual observer and the meteorologist would note when they looked upon the same stretch of rising flood waters. The former might observe that the water was getting near the top of the flood wall; the meteorologist would get the rapidity of rise by checking gauges.

SELECTING THE SCENE

After the technical observer has determined the specific reason for his observations and has put it into some definite statement, he must next find the scenes that will bring out this purpose. Here, again, he can well adopt the practice of the camera enthusiast who on any and all occasions is alert to the photographic possibilities of everything that he sees, yet who takes pictures only of scenes, structures, and actions that have some distinctive features in relation to his interest, knowledge, and experience.

For practice in writing the observation report, the student should be guided in the selection of a topic by the following considerations:

1. The writer's relation to the project. Does he have any knowledge of the activity or the product that he is going to see? Or has he only an absorbing interest in the basic principles of which the particular processes or procedures are examples? If he has previous knowledge, he can more readily set the range of his observation, and more skillfully focus his attention upon pertinent matter. If he has only an absorbing interest, he will have the desire to see an example of a project which he can expect in the active practice of his profession.
2. The aspects of the project. Is it easily accessible? What type will it be —a manufacturing process, construction, a plant or field layout, a commercial laboratory?

GETTING PERMISSION TO VISIT

After he has narrowed his possible projects to the one that he can handle best, he must get permission to visit the plant or the property if it is not open to the public. Either he or some responsible person must explain to those in charge the reason for the observation, *i.e.*, the uses to which the facts of the observations are to be put. In the case of the student writing a paper for an English course or for a professional course, it is information for discovering the relation of theory to practice, and for furnishing interesting subject matter for trying out writing skill. It is not to aid a competing organization or to expose conditions. It is an impersonal fact-finding project. There must always be scrupulous regard for any confidential matter. If there is the least doubt as to whether certain facts might fall under this classification, it is advisable to omit them in the general discussion. For a restricted group of readers they might be retained; but if the discussion is widely circulated, or ever published, the writer should be sure to have his facts released. Releasing is permission to use the facts, with the understanding that proper acknowledgment will be given in the letter of transmittal or preface, and in a footnote on the page in which the released information appears.

OUTLINING FOR NOTES

In the observation report more than in any other type, the directive outline, worked out before arriving upon the actual scene, is helpful.

By it can be picked out readily the features on which notes should be recorded at the time of the observation, or which are to be remembered as the mental notes to be recorded later. In purposive seeing, therefore, preparation can be made beforehand, so that the facts can be collected for later reference. The value of the directive outline for all fact-finding activities preceding the actual writing of a report has already been noted in Chapter Four. Sometimes, notes may be taken on the spot; sometimes, a project may be visited but the taking of notes or the use of a camera is forbidden. Particularly under these circumstances, the observer should have in mind some general classifications for cataloguing what he sees. Yet, even where someone familiar with the process or procedure acts as a guide and points out the features related to the observation, the student has the task of remembering them. If he has a directive outline, he can proceed with more sureness, for without overlooking any salient points he can get at the key features with less effort. In addition, even though the observer is assisted by a guide, if the observation is not merely general he may have to interpret the guide's remarks for their significance to a special purpose.

As guides, therefore, plan the route and features of a tour, the writer of the observation report should make his preliminary outline for an observation in connection with his tour. It does not preclude additions or modifications that result from the exigencies of the immediate survey. An open mind is always a necessary qualification for every kind of scientific study. It means a planned approach, a part of all good scientific procedure.

Since there is usually so little opportunity to review the facts of an observation, aids to the notes are very desirable. On his trip through a plant the observer may be handed sales pamphlets, guide sheets, or souvenir booklets. Then, there are the sketches of plant layout and the photographs, where permitted. These, together with information that can be gleaned from advertisements of products of organizations in trade journals and accounts in professional magazines, are means of confirming the facts of the notes. Interviews and questionnaires are also a means of supplementing notes.

A practical directive outline for collecting the facts for the observation report includes the following points:

1. Brief definition of the limitation of the purpose.

2. General first impression, noted under words that indicate extent, appearance, condition, atmosphere. These might be conveyed by such sensory words as vast, crowded, untidy, well-kept, run-down, spick-and-span, smoky, spectacular.
3. Conspicuous details.

   a. Outside a plant, the raw materials, yard layout, traffic routing, etc.
   b. Inside the plant, the biggest or most spectacular pieces of equipment. Possible comparison with familiar things.
   c. Processes, the most interesting, spectacular, unusual, familiar.
   d. Outstanding physical features, such as layout of a field for special uses in crop rotation.
   e. The personnel, *i.e.*, the workmen and their relation to the apparatus or the process or project.
   f. Unusual and seemingly unrelated features.

4. The finished product, or the complete effect or result. Here enough details should be noted to suggest outstanding general features, such as quality of workmanship, variations or range of uses, means of storing, shipping, and final marketing.
5. General final impression. This may confirm, modify, or contradict the first impression.

ARRANGING TOPICS

Order is an important factor in collecting and reporting the facts of observation. It may be time, progress, or known-to-unknown order. Therefore, it is desirable to have some actual route and progress in seeing. Purpose, personality, convenience, knowledge determine in a large measure the order to be followed. In observing a manufacturing process, the order may be from raw materials to finished product, the most natural; or from finished product to raw material, often the most interesting and the one most used in giving a nontechnical account of a technical subject. For instance, a visit to a canoe factory began in the basement of the plant where the logs were drawn in from the river and peeled, then sent up to be sawed into the appropriate sizes of lumber, heated, treated, shaped, covered, until graceful, colorful, and finished canoes were put on the roof for final inspection. It might have begun with the finished canoe and worked back to the logs.

A second starting point is with the general impression. Though difficult at first glance, it is worth striving for. This general impression

comes from conspicuous, visible, material features, or from characteristic sounds, smells, color, shape, dimensions. Buildings, grounds, state of cultivation, growth give some impression upon first sight. This first impression comes from a fleeting glance at features which closer view may show have momentarily been given disproportionate emphasis. First impression comes, too, from the extent of the panoramic view, *i.e.*, the most unobstructed and complete view of the whole in every direction. This is a guide to the route and the stations of the whole observation.

First impressions should be checked carefully for accuracy, relations, and proportions. In passing, it is well to note that the observer is limited by the time at his disposal. He cannot expect to get a thorough and well-proportioned picture of the whole plant on his first trip, any more than he can expect to get extensive details from his first trip abroad. The few important and general features are all that he can expect. In reporting on this type of tour, such lack of extended observation should be stated, though the most interesting and the most spectacular are likely to be included.

The discussion thus far has been concerned with material and apparatus as the observer moves from place to place. There are some variations of method if he stays in one place. Under these circumstances, the observation comes from "breaking down," or verifying, the general impression. Take, for instance, the impression of spaciousness and of order that an observer may get from the layout of his college campus. What gives that impression—arrangement of the buildings around a quadrangle? the open spaces? the vistas? the maintenance of grounds, dimensions, distances? Does detailed observation confirm the first impression? This first impression can be checked by the conclusion, the result of knowledge. Thus is the general impression "broken down."

Beginning.—In writing up the facts of observation, a definite procedure in planning the writing will be helpful. In the opening paragraph should be set forth the point of view, the location of the observer, the starting point of a tour, the time of day, and the general first impression, or the first reaction to the "scene." Recall how photographs in newspapers often have a note to indicate the place where the camera was set, and the point of the compass toward which it faces, as, "The city from the City Hall, looking west." Every map, too, has a compass notation.

Body.—Next come the developing paragraphs, in which numerous facts assembled give the pictures of units. These, in turn, make up the whole account. For example, consider the construction of a tall building. A first report on the building site might describe exactly the area, the building then occupying the site, the tenement houses, the storerooms, and other visible features. A second might report conditions after the site had been cleared—the excavations for the foundation complete, the materials assembled ready for the construction to start, the temporary offices erected. A third might present the whole situation after the steel members were in place. In fact, in every distinctive stage of the building an observation report could be made. Another example might be a report on the growing of a crop, such as corn or wheat, or caring for an orchard. Here the stages of observation would include the preparation of the land, the first growth, the mature growth, the harvesting, even at times the marketing of the crop. These observation reports especially might be compared to the slow-motion pictures. The important thing to remember is that the data for them are collected by actually seeing them.

If the object or feature described is stationary, there is need only to work out the best order for assembling to give the individual pictures, and to select words that keep the enumeration of details from becoming monotonous. If the observer must change his point of view, he must immediately inform his reader of this change. Otherwise, he will get the same effect in his picture in words that the photographer gets when he inadvertently takes two pictures on the same plate; they are blurred and valueless as photographs for either subject. The observer may indicate changing his point of view by such phrases as "passing on to the next plot, the seed bed" or "walking on to the pattern shop." It might be well to list a few so that they will be available during revision. In describing the stages or progress or changes in matter under observation, it is well to follow either the time (chronological), or the space (arrangement and relation) order. Again, the writer may profit by studying the methods of expert photographers who photograph every stage. The number of developing paragraphs, or "photographs," depends, of course, upon the extent of the project under observation.

Conclusion.—In the conclusion, special care should be taken to check the final impression against the first, to emphasize the general

impression and the tone set in the opening paragraph. The result desired is a distinct, vivid, accurate photograph, series of photographs, or panoramic view. Compare the opening and closing paragraphs in any popular account of an interesting process or procedure that is based upon observation.

INSPECTION REPORTS

The discussion thus far has been concerned with the collecting of data by means of actually looking at a project or procedure. *To observe* means to scrutinize carefully, *i.e.*, in detail; *to inspect*, to examine carefully and critically. The elements of care and detail are involved in both observation and inspection. The difference is indicated by the word *critical*. This implies, of course, expert knowledge on the part of the observer, for a critic is competent only insofar as he has extended and thorough knowledge of his subject. Training and experience in observation are necessary preliminaries to inspection, and skill in observation makes for skill in inspection. The degree of examination, rather than difference in basic principles for collecting and presenting data, differentiates the two. In fact, observation often merges into inspection. The purpose of inspection is frequently narrowly circumscribed. Often a formal standard outline or blank is set up for recording the data observed. On this are itemized the points on which specific facts are sought. This is the practice for routine inspections on any construction or maintenance project.

An account of two simple methods for gathering data concerning the layout of a university campus will show the differences between observation and inspection. During Freshman Week at a large university, the incoming first-year students were taken on a tour of the main campus. When the directors of Freshman Week planned this tour, they determined the limits by the time allotted to this project on the schedule, the relative importance to the freshmen of the activities that are carried on in the different buildings, the accessibility of the visible features, and the immediate use of the building by the freshmen. Thus, the library, the physical education building, the freshman laboratories with their equipment could be observed. The other buildings were not entered but pointed out. Emphasis was given to those that were of interest largely to the entering students. But with only two hours to make the tour, obviously no extended visit could be made even to the most important, and

the detail for all was necessarily brief. This tour would furnish the data for an observation report. Later, after these same students had become familiar with the campus and perhaps seen the campus of some other university, they might make an inspection trip of their own campus.

Critical Element in Inspection.—The important point to remember is that inspection implies critical ability that comes from training, or its equivalent—experience. As a result, inspection includes not only information but also evaluation. The freshmen, for instance, who go to see power plants, model farms, commercial laboratories, and other activities built upon the practical applications of scientific principles will write observation reports. They record what they see and draw conclusions upon their general impressions and knowledge. When they have reached their junior and senior years, they have acquired some of the fundamentals of the applied science used in the power plant, on the model farm, and in the laboratories. They can see beyond the externals to the significance of what they observe; hence, their reports will be inspection reports.

MAKE-UP

The make-up of the report on inspection and observation should follow the usual order and style of cover, title page, letter of transmittal, and table of contents; but the items of the letter of transmittal should be checked against the following:

1. Statement of the subject and the authorization.
2. Brief comment on exact geographical location of project observed or inspected, the time, the season, the length and other necessary limitations, such as those resulting from difficulties involved as inaccessibility, lack of opportunity for more than one trip. (These are often repeated in the introduction of the report proper.)
3. Acknowledgment of courtesies extended and help rendered. Always give the names and positions of the people who have helped.
4. Acknowledgment of sources of photographs and graphic material of *all* kinds. (If a brief digest of the theory or history is necessary, a footnote in the body of the paper should be used, as well.)
5. Acknowledgment of sources of supporting evidence, such as experience in the same type of project or related reading. This would not justify, however, the omission of a footnote in the appropriate place in the discussion proper, if some brief digest or history of the theory is necessary.

6. Courteous final sentence may or may not be used. Such a sentence, if it is felt to be necessary, should be sincere, concise, and convincing. It is better to make the tone of the whole letter convey this attitude.

Though the final report, whether it is experience, observation, inspection, or research, is influenced naturally by the writer's familiarity with the subject and the reader's need for information concerning the particular project, as far as is humanly possible, the observation or the inspection report should be the result of unprejudiced, impersonal, scientific seeing. The trained observer faces and records facts as they are—not as he desires them to be—and he records them in such form that they are accessible and clear years later. Of course, he can never entirely detach himself from a particular activity; but he should approach his study with an open eye. The individual feature of observation and inspection reports which will prove most valuable is the photographic feature. The student should remember that while he is improving his powers of observation he is becoming a better applied scientist, as well as a better writer.

Example: Observation Report[1]

Let us make our own inspection of the operating part of the ship to see these flying seamen at work aboard the Clipper.

The navigation room is just forward of the lounge. A table eight feet long and a yard wide takes up a large part of this compartment. Two big Pacific charts are fastened to it. On a shelf above the charts are books of navigation tables and two sextants. Pads of scratch paper, a loose-leaf log and a dozen pencils complete the equipment.

Beneath this work desk is a large box of aluminum bombs, light-weight metal balls with a tail to guide them as they hurtle downward toward the blue water. They are filled with aluminum powder and when they strike they burst, spreading the glistening particles on the restless waves and giving the navigator something on which he can train his drift indicator to discover what side-winds may be doing to drive the Clipper off course.

Further help in charting the plane's position comes from the shore stations, from ships and from the islands ahead. With radio direction finders these stations pick up the Clipper's signals and send messages informing the navigator of the plane's bearing in relation to the stations. The navigator

[1] From Lyman, Lauren D., "Flying the Clipper: A Machine-age Drama," in *The New York Times Magazine*, Nov. 22, 1936, pp. 4, and 20. Used by permission of *The New York Times*.

quickly draws fine lines indicating these bearings and at their intersection he fixes his position.

But radio is not exact, and the Clipper is moving ten times as fast as the average surface craft. Other checks must be found. In the daytime a sun shot with the sextant helps. At night the friendly stars are moving in their ordered paths and from them the navigator learns where he is more accurately than in any other way.

Thus with stars and sun, with radio and compass the navigator keeps the Clipper on her course.

Through another doorway forward the way leads to the "bridge." There in the nose of the Clipper with slanted windows ahead, sit the two pilots. A third pilot is there enclosed in a small box. Two gyroscopes, one turning in the vertical and the other in the horizontal plane, make up the automatic pilot which actually does the flying as the human pilots stand guard over it.

Here is noise, the roar of mighty engines; here are clicking recorders and twinkling lights, dials and meters which two expert pilots watch during every minute of the flight. The pilots sit relaxed, studying the cloud formations ahead. They see conditions which their meteorological training tells them may mean squalls and a shift in wind. The automatic pilot shifts the controls again and again to meet every gust and flurry, every change in air pressure, while the human guardians look ahead to the next problem.

To the right and on the same deck, aft of the twin pilot seats, is the cubby of the radio man. He has a desk about two feet square and pads of paper. He can reach his messages forward to the skipper or use the telephone if the skipper isn't paying attention. After a glance at the message, containing radio bearings or news of more passengers and mail at the next stop, or warnings of storms ahead, he sends it back to the navigator. The radio man has his scheduled contacts with the land stations every thirty minutes.

Behind the radio cubicle and on another deck perhaps three feet higher—in the center of the very wing itself—is a passageway along which one travels on hands and knees for ten feet to reach the station of the engineering officer. Here he sits in a canvas deck chair, completely surrounded by dials. On his knees is a large pad lined like a bookkeeper's ledger. On this he makes a detailed record of engine performances.

Dials and meters tell the engineer what is going on inside the four engines. He records the revolutions per minute at a given throttle setting. He sets down the temperatures not only of each engine but of individual cylinders. He writes the altitude at which this action takes place, the temperature of the oil, the amount consumed, the gasoline consumption, the setting of the propellers, and he notes, for example, just what he does to cool No. 5 cylinder in No. 2 engine on the port side if it is running hot.

He makes 170 entries an hour in his log, more than 10,000 separate records for each voyage of the Clipper. At each stop this history is studied by the chief mechanic, and the motors are treated according to the prescriptions indicated by the record.

Problems

Topics for observation and inspection reports:[1]

A visit to an ethical drugstore, a pet clinic, an experimental seed plot.

A visit to a stock farm, a small fruit farm, a truck garden, a hatchery, a serum laboratory, a poultry farm, a dairy, a commercial greenhouse, a college laboratory.

A visit to a foundry, a power plant, a manufacturing company, a brick plant, a pottery, a mine, a construction job, an engineering project such as the building of a dam, sewage disposal plant, waterworks, an observatory.

A visit to a cafeteria, a division of a large department store, a model house.

An erosion control project; a field trip.

An exhibit of china, of books, of pictures, of sport trophies.

A hobby show, a machinery exhibit, a dog show, a horse show, an automobile show, an educational exhibit.

A trip through the Weather Bureau, a particular display in a museum, the layout of an aviation field, the dispatcher's room at the aviation field, the supply room of a machine shop, a newspaper pressroom, excavation for the basement of a house.

Major commercial or industrial interests of my home town.

[1] Additional topics will be found in the problems for technical description, Chapter Ten, p. 163, and for observation and note taking, Chapter Three, p. 36.

Chapter Thirteen

The Simple Research Report

CULMINATION OF REPORT WRITING

The research report, even in a simple, short form, is perhaps the most ambitious kind of writing that the undergraduate is asked to attempt. It is the culmination of his reports on experience, observation, and inspection. Although reading will supply most of the information, these earlier sources, together with original thinking, are still to be exploited for good material. In the same way all the resources of effective writing are needed for success in the research report. In the present discussion, however, so much space is needed for special methods of procedure and forms of assembling that a general basic knowledge of the principles of composition will have to be taken for granted.

CHOOSING THE PROBLEM

At the very beginning the exact nature of the problem for investigation may not be clear unless it is fixed by assignment. Often, the student may have a general subject in mind. For example, a student, say, of agriculture or engineering may know two things about his problem at the assignment of the paper. These two things may be: (1) that the paper is to be of approximately 2000 words, (2) that it is to be about water conservation. If he thinks over his problem long he will, of course, see that any 2000-word treatment of so vast a subject must of necessity be superficial. Work of that kind is to be avoided, even in simple research; and the way to avoid it is to take so small a section of a large subject that a 2000-word treatment of it will be complete, comprehensive, and adequate. Therefore, our researcher might well determine his subject by going down the following steps.

1. Water conservation.
2. Water conservation by use of low dams.
3. Water conservation by use of low dams in small streams.
4. Water conservation by use of low dams in small Ohio streams.

As the number of words increases, the scope of the subject becomes narrower. In determining when to stop narrowing the subject, the student must rely upon his own judgment. Often, after he has made considerable headway with his research, he will find that his subject is too broad or too narrow and must be changed. In fact, he may be adding parts to his subject or eliminating them from it all during his writing. However, the preliminary determination of the scope of the subject should be based upon the following factors:

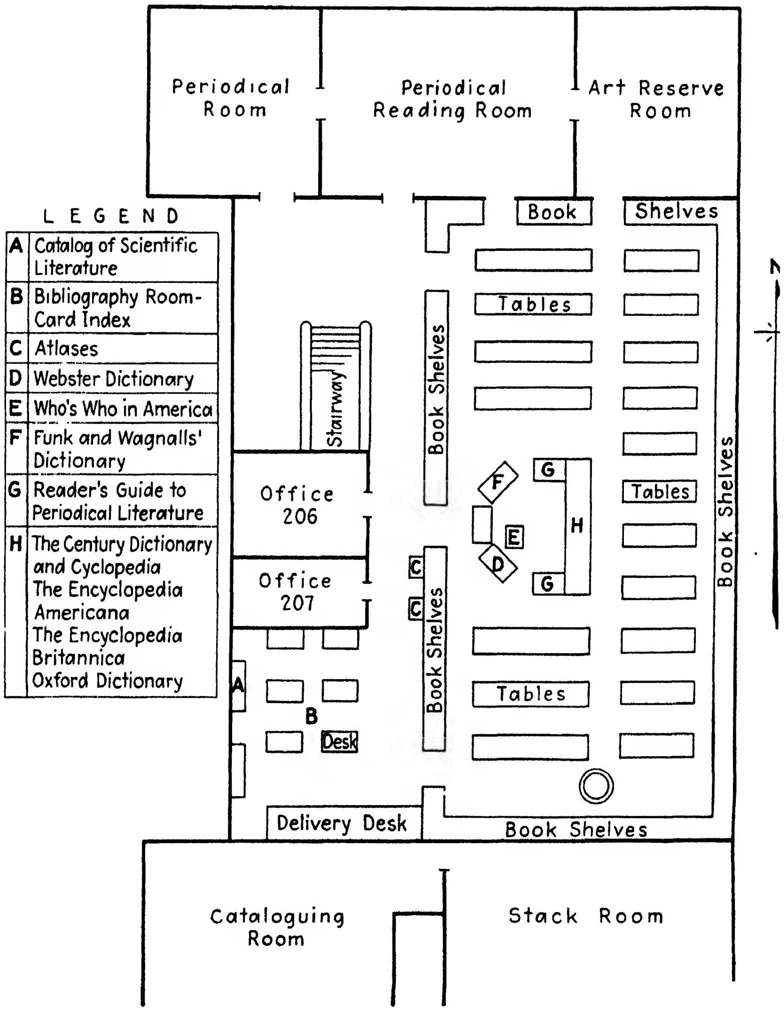
1. Audience.
2. Availability of material.
3. Limits set for length of paper.
4. Student's previous experience with the subject.

DISCOVERING THE MATERIAL

When the student has chosen his subject, he is ready to begin his search for information. Most of this search will take place in the library. Before he can make any headway, he must be able to locate and use four things: books, periodicals, indexes, and card catalogues.

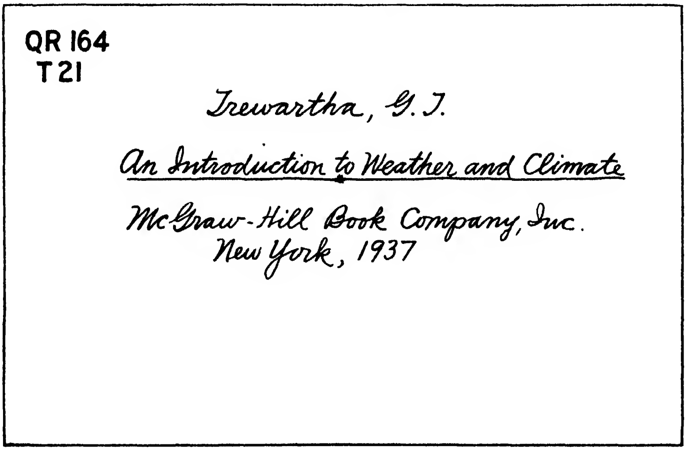
Before the student can efficiently locate such material, he must have a general knowledge of the arrangement of the rooms, desks, shelves, and books in the library. This knowledge should be acquired in a systematic manner and should be well in hand before the student attempts any of the actual work of research. If the library supplies maps, he should acquire one at once and should study it. If no ready-made map is available, he should make his own. On page 203 is a map of a large university library. This map was made by a student. It is not complete, because when the student made it he had had no library experience. He gathered his information for the map by observing, by reading signs, and by asking questions. When he had completed his map, he knew where the most important things in the library were.

The first step for the student research worker to take after he has made his map is to find out what has been written about his subject and how much of this is in the library. As he locates the names of various publications having to do with his subject, he will record them for future reference. The resulting list of publications having to do, wholly or in part, with his particular subject will be called his bibliography. It is only sensible that his bibliography be kept in the most convenient form. Experienced research workers have found

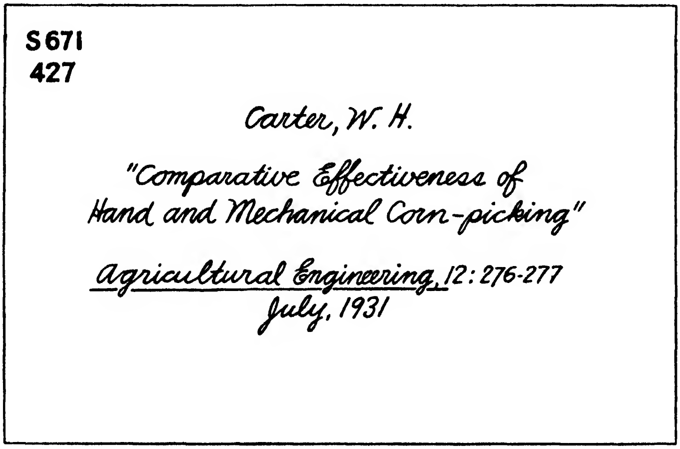

Periodical Room
Periodical Reading Room
Art Reserve Room
LEGEND
A Catalog of Scientific Literature
B Bibliography Room-Card Index
C Atlases
D Webster Dictionary
E Who's Who in America
F Funk and Wagnalls' Dictionary
G Reader's Guide to Periodical Literature
H The Century Dictionary and Cyclopedia
The Encyclopedia Americana
The Encyclopedia Britannica
Oxford Dictionary
Book Shelves
Tables
Stairway
Office 206
Office 207
Desk
Delivery Desk
Cataloguing Room
Stack Room
N

this to be the card bibliography. Such a bibliography is made up of small cards (3 by 5 inches or 4 by 6 inches) each one containing information about a single publication.

Card for a book



Card for a magazine



At the very outset, the student should go to the book card catalogue. This is much the same in all libraries, and consists of large cabinets filled with drawers containing cards. Each book in the library is represented by three cards, all three of which contain approximately the same information arranged differently. The

Card for a bulletin

S21
A6
No.773 Hartley, C.P., and L.L. Zook

"Corn Growing under Droughty Conditions" U.S. Department of Agriculture Farmers' Bulletin, No. 773, U.S. Department of Agriculture, Washington, D.C., 1916

important difference in the three cards is in the headings which are used for classification. For example the book *Modern Diesel Engine Practice* by Orville Adams would be listed as on the three cards which follow.

TJ 795 Adams, Orville
A 22 Modern Diesel Engine Practice

TJ 795 Modern Diesel Engine Practice
A 22 Adams, Orville

TJ 795 Diesel Motors
A 22 Adams, Orville

Modern Diesel Engine Practice;

The first card will be found among the A's, because the last name of the author begins with that letter.

The second card will be classified by the first letter of the *first important* word in the exact name, or title, of the book.

The general subject of the book is *Diesel Motors*. Therefore the third will be listed with the D's.

The first search will probably be for subject cards alone, for at this early stage the researcher seldom knows either titles or the names of authors in his field of research.

From the information given on the library card the researcher can often tell, without taking the book from the shelves, whether or not it will be of value to him. He should look for the following points:

1. *Date.* Is the work too old? Has it been superseded by more recent works on the subject?
2. *Author.* Does it happen that the author is well known for his work?
3. *Publisher.* Is the publisher well-known and reliable?
4. *Size.* Do the number of pages or the contents generally given on the card indicate that the book may be an exhaustive treatment?
5. *Illustrations.* Does the book contain maps, graphs, or pictures which might be used?

In library research it is generally advisable to build the bibliography to as complete a form as possible before starting the reading and note taking. As soon as the researcher has made his preliminary survey of the book card catalogue, he should find out what bulletins and magazine articles have been written on his subject, and whether or not these are in his library.

At this point he should go to the magazine indexes. These are of two kinds: general and special. The two kinds differ from each other only in the magazines which they list: the general indexes listing magazines which cover a wide, unrestricted range of subjects; the special indexes listing only the magazines and bulletins of some profession or interest.

The five most important general indexes are:

Readers' Guide
The International Index
Annual Magazine Subject-Index
Poole's Index
The New York Times Index

The three most important special indexes are:

The Agricultural Index
The Engineering Index
The Industrial Arts Index

Detailed information concerning these indexes is given in the bibliography following this chapter.

The entries in these indexes are in abbreviated form, in order that a great number of articles may be listed without making the volumes too bulky. To the uninitiated these abbreviations may seem unintelligible, and therefore it is well to examine one at this point. The following is a typical entry from *The Readers' Guide.* It is found under the general subject "Earth."

Earth as an engineering structure.
W. Bowie. *Sci. Monthly* 32: 457–60
My '31.

Information given in this entry is:

Name of article. Earth as an engineering structure
Author. W. Bowie
Magazine. Scientific Monthly
Volume. 32
Pages. 437–460, inclusive
Date. May, 1931

Each volume of *The Readers' Guide* contains a key to the abbreviations used therein. Entries in other periodical indexes differ in no important manner from the one given here.

As the researcher locates the titles of articles and books in the indexes, he, of course, records them so that he may determine whether or not they are in the library in which he is working. Although it is *advisable* to record each title on a separate card at this stage of the research, it is *essential* that separate cards be used in the stage which follows.

After the periodical indexes have been covered thoroughly, the researcher is ready to find out which of the titles he has just obtained are represented in the library. In order to determine this, he must first consult a list of the periodicals his library contains. This list is generally called a *periodical card catalogue* and is not to be confused

with magazine indexes, such as *The Readers' Guide*, *The Agricultural Index*, etc. It is similar in form to the *book card catalogue* which the researcher has consulted at an earlier step of the process. However, it is smaller, because it lists all the volumes of each particular magazine on one card. This periodical card catalogue does not list authors or titles of articles, only titles of magazines and an indication of which volumes of the magazine are in the library. It is, then, by consulting this periodical card catalogue that he determines how many of the magazines that he needs are in the library.

At this stage of the process, the researcher has two stacks of cards: one containing titles of books, the other containing titles of magazine articles. These two should be combined. The resulting stack of cards will be his bibliography in its first form. This bibliography will grow, decrease, and change during the subsequent steps in the research, but at this early stage it represents the first part of the paper to take actual, concrete form.

While the researcher has been going through these lists of titles, the general topics to be covered in the paper have been becoming more definite. Perhaps they have become definite enough to be formulated and put down in black and white. Certainly, at this stage of his research the student knows in general what he will be looking for when he starts reading and taking notes. These main points around which information is to be collected should be put down in the form of an outline and used in the gathering of material. Such a preliminary plan is called a directive outline. Its use is discussed in detail in Chapter Four. When he has constructed the directive outline, the paper itself has begun to emerge.

However, the researcher is not through with bibliography building, and before the next step is discussed, which concerns the peculiar kind of note taking demanded by research, bibliography building must be more thoroughly disposed of. He cannot depend entirely upon indexes and catalogues for bibliography. For as a rule, he is not well enough acquainted with his field of research to know what all its possible subject, title, and author classifications may be. So when he has exhausted the index and catalogue material, he should look to bibliographies already compiled by previous workers in the field. Ideally, he should do this first of all and save time, but usually it is only through indexes that the beginner can locate bibliography already prepared. However, it is possible to locate a short bibliog-

raphy on nearly any subject by consulting either a general or a special encyclopedia. In these reference books, short bibliographies usually follow the articles. Furthermore, the researcher can get some idea of the scope and content of his subject by consulting one of these books early in his research.

He should next go through his stack of cards, sorting out those which he thinks are likely to be more complete and authoritative. If, for example, he chooses three books, he should withdraw them from the library and examine them for further bibliography. He should look in four places: (1) in the body of the text, where the writer may have mentioned other authorities and their works, (2) at the bottom of the pages, where titles may appear in footnotes, (3) at the end of chapters, where the author may have compiled a list of references, and (4) at the end of the book, where there may be such a list. After recording these titles gathered by other people, he should check to see which are in his library, just as he did with the items taken from indexes. While many of the books will not be there, those that are will probably be a valuable addition to his bibliography.

No definite specifications can be laid down concerning the size of the bibliography at this stage of the process. Certainly, an energetic researcher pursuing a timely topic in a good library should have from thirty to fifty cards. He will, of course, eliminate some of these when he gets the books and magazines in his hands, for he will find that some are of no value and that others duplicate information.

RECORDING THE MATERIAL

At this point, the researcher has in his possession a working bibliography and a directive outline. Unless he has both, he is not prepared to assemble material in the form of notes.

Note taking in general has been discussed in a previous chapter, but note taking for a research paper requires special methods. These methods must be discussed here.

As the researcher takes books and magazines from the shelves of the library for the purpose of extracting material from them, he should examine them and judge them carefully. It is impossible for him to decide correctly whether every book that he uses is an adequate treatment by a competent authority. However, he can separate much of the chaff from the grain by asking himself the same ques-

tions that he asked when he located the title in the card index. Those questions concerned:

1. Date
2. Author
3. Publisher
4. Scope
5. Illustrations

Notes should be taken on cards not smaller than 4 by 6 inches and not larger than 5 by 8 inches. It is well to have the note cards larger than the bibliography cards, in order that they may be easily separated if they become mixed. Each note card should contain three things: (1) a classifying entry at the top of the card, (2) the body of the note, made up of the information to be used in the paper, and (3) at the bottom of the card a record of the source.

These three parts are illustrated in the examples of student note cards as shown on page 211.

The classifying entry at the top of a note card will, if used accurately, save time and prevent confusion. Suppose, for example, that a researcher has chosen his subject, located and assembled his working bibliography, and constructed the following directive outline:

OBESITY

I. Introduction
   A. Definition
   B. Prevalence
II. Causes of Obesity
   A. Heredity
   B. Extent of glandular activity
   C. Activity habits
   D. Food habits
III. Effects of Obesity
   A. Basal metabolism
   B. Diseases associated with obesity
   C. Other effects
IV. Treatment of Obesity
V. Summary and Conclusions
   (Home Economics 612)

I., B.
Qualifications - Educational

Necessary to be graduated from at least a four year forestry school of recognized professional standing or its equivalent. Increasing no. of students are taking graduate work upon completion of their undergraduate study. Most forestry organizations provide practical work for young foresters in their service.

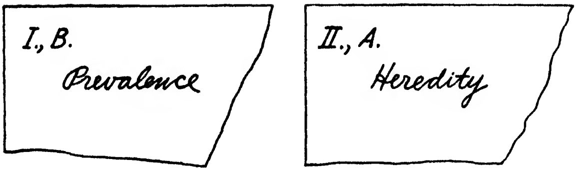
Illich, Joseph S., <u>An Outline of General Forestry</u> p. 227

II., C.
Scope and character of forestry

First of all concerned with the constructive management of forest land.
Forestry deals with special classes of soils
a long-time crop
trees in the mass
gives much attention to the soil,
presents destructive problems in character of its product.
The forest is a broad physiographic factor

Graves and Guise, <u>Forest Education</u> pp. 3-8

As he consults his first book on the subject, the researcher is likely to find that it contains material to fit more than one part of his outline. If he finds valuable material about parts I, *B*, and II, *A*, and if he decides to extract notes on this material, he should be careful to use as a classifying entry the part of the outline under which this material will fall. The tops of the two note cards will look like this:



If the two paragraphs of material which are to be used in different parts of the paper are put on the same note card or given the same classifying entry, the researcher will waste time sorting notes when he starts to write the paper. If he follows the system here recommended, he will save time and prevent confusion, because when his notes are all gathered and he is ready to organize and develop his information into a coherent whole, he will find his material accessible for easy classification.

When he sits down at his desk to start the first words of his first draft, he has only to look at the first topic of his outline, separate the group of note cards which have that heading, and his material for that section is ready to go into the paper. Then, as soon as he has written this first section, he may put aside those notes which he has just used. Thus, as he passes from section to section of the outline, he need not go through his entire supply of notes each time as he would need to do were they not classified. Instead, he writes each section of his report as he goes, and then assembles the whole.

This method of classifying notes as they are being taken also helps to keep papers from having bad proportion. For, as a student collects and heads his notes according to the topics of his directive outline, he has before him the growing stacks of note cards and (by comparing the size of the stacks) he is able to decide whether or not he is collecting too much or not enough material on any topic or topics.

The second part of the note card, the body, is of course the most important. It consists of the material to be used in the paper. A detailed discussion of the body of the note card is to be found in Chapter Three. This material can be placed on the note cards in one or both of two ways. It may be condensed into the student's own words or it may be quoted exactly as it is found on the printed page. If the student condenses some one else's material, he must take care that he does so with exactness. That is, he may change the wording, but not the meaning of material which he is using. On the other

hand, if he records the exact words of an author, he must be sure that they *are* exact. If space or clarity necessitate his changing a quotation, there are methods of indicating that it has been changed. If these are used, it is perfectly honest to leave out words or add them whenever the occasion demands. In the following quotation the dots (. . .) indicate that the note taker has omitted some of the author's words and the brackets indicate that he has added some of his own.

Description
I., C.

"The soy bean is an annual, two to four feet high
[Some of the strong stalks grow even higher].
The flowers are inconspicuous, of pale lilac
or violet color [according to variety]. When grown
for the seed..... sometimes yields as high
as 40 bushels or more to the acre ..... average
is much less."

Encyclopedia Americana, Vol. 25, p. 319

The third part of the note card is the record of the source. It must be accurate and complete. In careful writing it is necessary to acknowledge the source of your information. Such acknowledgment is a sign of the writer's honesty, knowledge, scientific point of view, and good judgment. It also serves as a genuine accommodation to the reader, for it tells him where he may look for further information on the subject. When, in the writing of the paper, the student turns to his note card to find where his information has come from, so that he can make such acknowledgments, he should find complete information which he has previously recorded.

There are four places where he may acknowledge his sources. They are: (1) In the preface or letter of transmittal, (2) In footnotes, (3) In the body of the text, (4) In a bibliography at the end of the paper.

EXAMPLE: PAGE FROM A STUDENT REPORT

"With indifferent management it [the organization] faltered and weakened succumbing to a slow death two years later (1909)."(1) The report of the Federal Trade Commission suggests that the organized opposition of the dealers had something to do with its failure.(2)

Mr. Quackenbush draws the following conclusions from this attempt:

> Two things which stood out above all others in this period were the fact that the organization attempted entirely too much work for the staff which they could afford to pay on their basis of commissions and that the records kept of the business . . . and of the things which took place, were entirely inadequate.(3)

Cooperatives Operating from 1914-18.—In the spring of 1916 the producers around Austinburg and Jefferson, Ohio, reorganized as the Dairymen's Cooperative Association, the chief reason for organizing being the unduly low price of milk. This organization took place in Jefferson, Ohio, in May, 1916, and was to have an extremely far-reaching effect. Instead of trying

---

(1) Rummell, L. L., "Farmers Unite 12,000 Strong," Ohio Farmer, 153:659, Mar. 17, 1924.

(2) U. S. Federal Trade Commission, Cooperative Marketing, p. 36, U. S. Government Printing Office, Washington, D. C.

(3) Quackenbush, E. R., The Dairymen's Cooperative Sales Company, p. 7, Dairymen's Cooperative Sales Company.

—Marshall Hervey.

Acknowledgments in the preface or letter of transmittal are generally confined to people who have given the writer personal assistance in the preparation of the report. The following example is the concluding paragraph of a letter of transmittal.

> I am deeply indebted to Mr. Chadwick and Mr. Bosely for aid in locating material and for their many helpful suggestions. Also I wish to express my appreciation for the advice and help given me by Miss Freida Cohen and Mr. Donald Loomis.
>
> Yours very truly,
> William E. Gunesch

Footnotes are the most common form of giving acknowledgments. A footnote may explain technicalities or give cross references to other parts of the same report, but its most important uses are to acknowledge, verify, or supplement sources of information. The student should always use footnotes: (1) When he uses the exact words or figures of another writer, (2) When he uses an important idea from another writer, even though it is not verbatim, (3) When he wishes to give brief, additional information which does not fit into the body of the text.

Page 214, a page taken from a student report, shows an acceptable form of footnoting. Few publishers use the same form in footnotes. As a result, the student may find that different instructors require different footnote form in reports. Generally, the instructor prefers the form used by the most authoritative professional journal in his field. If such is the case, the student should examine a copy of the journal and follow its plan carefully.

The researcher should never make up his own system of using footnotes. There are too many systems now. If the instructor has no special preference in footnote form the researcher may use the following:

Book

Chase, Stuart, *Men and Machines*, p. 129, The Macmillan Company, New York, 1929.

Magazine

Gaylord, J. M., "Developing High Efficiencies in Large Single Stage Pumps," *Engineering News-Record*, 118: 45, Jan. 14, 1937.

Bulletin

Winter, A. R., "Poultry Feeding," *Bulletin of the Agricultural Extension Service, The Ohio State University,* No. 126, pp. 9–11, September, 1932.

The code used is near enough to all acceptable systems to be intelligible to any person at all acquainted with bibliographical procedure. The following is a list of abbreviations and Latin forms which are customary in condensing footnotes.

p.	page
pp.	pages
Vol.	volume
op. cit.	the work already cited
loc. cit.	the place already cited
ibid.	the same
l.	line
ll.	lines
Chap.	chapter
ff.	following

It should be observed that on the specimen page (page 214) the footnotes give complete bibliographical information about the sources. Such completeness is desirable in the first footnote reference to a source. However, in subsequent references the footnote may be condensed.

Many editors and teachers prefer an end bibliography to footnotes. In such a method of citation, the numbers which are placed in the body of the paper refer to a numbered list at the end, rather than to footnotes at the bottom of the page. This method makes the writing of the paper easier. On the other hand, it forces the reader to turn to the end of the paper each time that he wants to know the authority. Also, in this method it is harder to give exact page references if an article is referred to several times.

Although the researcher may have given complete information concerning his sources in footnotes, he should assemble a list bibliography for the end of his report. This bibliography serves two purposes. First, it places all his references, not only those quoted, but all that have been read in preparing the report, in a convenient list for the reader's use. Second, it may contain any additional references which were not used in the paper but which might be of value to the reader if he cared to go deeper into the subject. If only sources

actually used are placed in the bibliography (the usual practice in student papers), they may be arranged in one of two ways: alphabetical or chronological. Material given for further reading should be placed in a separate list. In the list bibliography it is customary to separate periodicals, bulletins, and books. This form can be observed in the sample list bibliography which follows. The information needed in the list bibliography can be taken from the bibliography cards.

EXAMPLE: BIBLIOGRAPHY FROM A STUDENT'S REPORT

Books

1. FERRIS, G. F., *The Principles of Systematic Entomology*, Stanford University, Palo Alto, Calif., 1928.
2. JAEGER, BENEDICT, *The Life of North American Insects*, Harper & Brothers, New York, 1859.

Periodicals

1. DE LONG, D. M., "Entomology in Relation to Industry," *The Scientific Monthly*, 25: 429–434, November, 1927.
2. ESSIG, E. O., "Man's Influence on Insects," *Scientific Monthly*, 28: 499–506, June, 1929.
3. MARLATT, C. L., "Another Real War is Upon Us," *National Republic*, 17: 5–6, November, 1929.
4. MUMFORD, E. P., "Studies in Certain Factors Affecting the Resistance of Plants to Insect Pests," *Science*, 73: 49–50, January, 1931.
5. REINHARD, E. G., "Insect Life," *Nature Magazine*, 15: 322–323, May, 1930.

Bulletins

1. JONES, G. D., "Garden Pest Control," *Missouri Agriculture Extension Circular*, No. 304, 1933.
2. KEIFER, H., "Miscellaneous Insect Notes and Descriptions," *California Agriculture Department Bulletin*, May, 1931.
3. METZGER, F. W., "Information Concerning Japanese Beetle Traps," *New Jersey Agriculture Department Circular*, Vol. 146, 1928.
4. PARMAN, D. C. and others, "Tests of Blowfly Baits and Repellents During 1926," *United States Department of Agriculture Technical Bulletin*, Vol. 80, 1928.
5. QUAINTANCE, A. L., and E. H. SEIGLER, "Information for Fruit Growers about Insecticides, Spraying Apparatus, and Important Insect Pests," *United States Department of Agriculture Farmers' Bulletin*, No. 908, February, 1918.

THE SUMMARY OR ABSTRACT

As the volume of scientific research has expanded in recent years, so naturally has the number of books and articles relating to research progress in all fields. A good research worker must keep abreast of the "literature" in his field, both to avoid duplicating work that already may have been begun or completed, and to make intelligent use of recent discoveries by his fellowworkers.

But to read completely every book and every article on even a limited subject would leave the research worker little time for his own work. For this reason, abstracts and summaries play an important and practical part in all scientific work.

As its title suggests, *Chemical Abstracts* offers condensations of articles and reports on chemical research; the *Journal of the American Medical Association* devotes a number of pages every month to abstracts from medical publications in every country. Even when a professional journal contains no formally labeled abstracts, usually its book reviews will be found to be in reality abstracts followed by critical comment. As the recent flood of popular magazine "digests" has shown, even the layman has learned to let abstracts keep him up-to-date and informed.

The abstract or summary does not, of course, completely replace the lengthy original. As a chemist reads *Chemical Abstracts* he will note certain abstracts which bear directly on his own work, and he will want to locate and read in full the original articles. But by first reading the abstracts he has learned what he needs to know of work in his general field, and he has been directed without delay to articles warranting more complete study.

Originally, the word *abstract* referred to a condensation resulting from the "lifting" and combining of important or key sentences from the original; the language of the original was thus preserved in the abstract. Today, however, the words *abstract*, *summary*, and *digest* are applied interchangeably to any compressed statement of a longer original. Rigid adherence to the language of the original serves little purpose and usually results in an awkward and disjointed product. In practice. the language of the original is used wherever it would be pointless to change it, but frequently transitional expressions must be provided and summaries composed.

The abstracter will have before him constantly two considerations: (1) the needs of the reader, and (2) the ethical necessity of fidelity to the *thought* of the original. On the first score, he may eliminate much of the original's treatment of preliminaries, historical introduction, technique, etc., in order to give most space to the author's statement and interpretation of the results of the work. When the original states a general fact or idea and then illustrates with examples, these can usually be omitted, or at least greatly condensed. No rule applies to all cases; in some articles, description of a new technique may be as important as the conclusion. The abstracter must act as an editor and determine which elements of the original will be of most value to his readers.

An undergraduate research report of 2500 words can be compressed into 500 words or less. One method is to go through the original, paragraph by paragraph, writing summary sentences for each. The principles of "subordination" as discussed in a handbook can be used to good effect here; sentences can be telescoped into clauses, clauses into phrases, phrases into words. When the abstracter has before him this group of summarizing sentences, he will group them according to the main divisions of his outline or table of contents. Each of these sentence groups may constitute a single paragraph for the abstract, or any sentence group may be split into smaller groups to make more than one paragraph. Frequently, as in the case of the example given below, a brief abstract of a brief paper can be given in a single paragraph.

When the sentence groups have been defined into paragraphs, the abstracter should subject the result to a double check. The first checking should eliminate any superfluous words or phrases which may have escaped the blue pencil in the first part of the process. Finally, the abstracter should try to read with the mind of one who knows nothing of the original, in order to make sure that no idea essential to an understanding of the content of the original has been omitted, and that sentences and paragraphs are connected by transitional words or phrases, where necessary for clarity and reading ease. Summarizing by paragraphs may easily result in a series of isolated and disconnected sentences, unless the abstracter supplies the necessary connections. Before the abstract can be regarded as finished, it should undergo essentially the same careful revision which is given to a longer, original report.

The following 500-word abstract is taken from a 2500-word student paper called "The Development of the Rayon Industry."

Example: Summary from a Student Report

SUMMARY

For sixteen years the Chardonnet process for manufacturing rayon was the only process used commercially, but it has gradually given way to newer, better, and less expensive methods. In 1934, the fiftieth anniversary of Chardonnet's invention, the last factory in the world operating under his (nitro-cellulose) method was closed. The cupra-ammonium process is cheaper than that of Chardonnet, but is not so cheap nor so widely used as some of the other methods. Of all the processes now in use, the viscose process has grown the most rapidly because the equipment and the chemicals required to produce it are so inexpensive. In 1934, this process produced eighty-five per cent of all the rayon manufactured in the world. The cellulose-acetate process was the last of the four processes to become commercially important, and, although it has grown rapidly, it still must prove its worth. At present, rayon has reached a great popularity, being listed as one of the five leading textiles of the day, and will undoubtedly continue to find steadily widening markets. It can be obtained in all the civilized countries, and can be produced at a cost which places it well within the reach of the entire buying public.

—Elizabeth Raup.

FINISHING THE REPORT

The student's abstract based on his own report may be placed either at the beginning or at the end, within the body of the report. Certain other special parts of the research report, such as a glossary of technical terms, an index, tables of data, or formulas, may also be needed at the end. These, together with the list bibliography, constitute the appendix matter. They are often labeled separately as Appendix *A*, Appendix *B*, etc. Their page numbers run continuously with the body of the report.

Before writing his research report in final form the student will profit by reading Chapter XIV, on Make-up for the Long Paper, and taking an inventory of all the essential parts. These parts may all be prepared from the card materials described in the present chapter. The pages which come before the body, which are numbered with Roman rather than Arabic numerals and which are called "front matter" by printers, include (in addition to the

unnumbered title page) the letter of transmittal, table of contents, and lists of figures and tables. The body of the report begins the Arabic numeral pagination. At the present stage it may be a first draft, with footnotes and headings roughly indicated, together with an abstract, if required. The appendix matter follows.

The final copy of the research report should be given special care. Not only in content and organization, but also in style, usage, and form is the research report the culmination of all reports and of all writing practice. Hence, instead of giving special directions here for the writing of the final copy, we recommend that the student review every chapter of this textbook, bearing in mind that good report writing results from the successful application of the principles of all good writing.

RESEARCH BIBLIOGRAPHY

I. *Library Guides*

HUTCHINS, MARGARET, ALICE SARAH JOHNSON, SARAH WILLIAMS, *Guide to the Use of Libraries*, H. W. Wilson Company, New York, 5th ed., 1936.

MUDGE, ISADORE G., *Guide to Reference Books*, American Library Association, Chicago, 6th ed., 1936.

WYER, JAMES I., *Reference Work*, American Library Association, Chicago, 1930.

II. *General Indexes*

Annual Magazine Subject Index, Boston Book Company, Boston, 1908–date.
Index of many magazines and publications not listed in other indexes.

Book Review Digest, H. W. Wilson Company, New York, 1905–date.
Monthly index of important books. Contains brief digest of each book with reviewer's evaluation.

Cumulative Book Index, H. W. Wilson Company, New York, 1898–date.
Up-to-date list of all new books in print in the United States.

International Index, H. W. Wilson Company, New York, 1920–date.
Index of many publications (especially professional magazines) not contained in *Readers' Guide*. From 1907 to 1920 this publication was called *Readers' Guide to Periodical Literature: supplement*.

The New York Times Index, *The New York Times*, New York.
Monthly subject index with brief synopses of some articles.

Poole's Index, Houghton, Mifflin Company, Boston, 1802–1907.
Index of periodicals and general literature of the nineteenth century.

Readers' Guide to Periodical Literature, H. W. Wilson Company, New York, 1900–date.
Index of large list of general magazines and miscellaneous publications.

III. *Special Indexes*

Agricultural Index, H. W. Wilson Company, New York, 1916–date.
Subject index to selected list of agricultural periodicals and bulletins. This list includes: (1) Bulletins of American and foreign experiment stations, (2) Publications of the United States Department of Agriculture, (3) Important Agricultural magazines, (4) Miscellaneous books, circulars, etc. on agricultural subjects.

Engineering Index, American Society of Mechanical Engineers, New York, 1884–date.
Index to selected list of American and foreign technical journals and publications.

Experiment Station Record, United States Department of Agriculture, Washington, D. C., 1889-date.
A technical review of the world's scientific literature pertaining to agriculture. Abstracts of results of current research in the various fields of agriculture, together with brief notes on the progress of agricultural education and research. Monthly editorials dealing with some phase of advancement in agriculture.

Industrial Arts Index, H. W. Wilson Company, New York, 1913–date.
Index of periodicals and miscellaneous publications dealing with engineering and industrial subjects.

IV. *Encyclopedias*

General

Encyclopedia Americana.
Encyclopaedia Britannica.
New International Encyclopedia.

Special

Condensed Encyclopedia of Engineering.
Encyclopedia of Food.
Encyclopedia of Practical Cookery.
Engineers' Year Book.
Hortus: A Concise Dictionary of Gardening.
Standard Cyclopedia of Horticulture.
Yearbook of Agriculture.

Dictionaries

Funk and Wagnalls New Standard Dictionary.
New Century Dictionary.
Webster's New International Dictionary.

Problems

1. Build a short practice bibliography of some contemporary subject. Have at least five entries of books and five entries of magazines.

2. Write a sample page of a paper from the first notes that you take. Include the following:

   a. A footnote reference to a book.
   b. A footnote reference to a magazine.
   c. A long quotation in the text.

3. Before the paper is put into its final form, give a section of it to the instructor. The section should be accompanied by three things:

   a. The part of the outline covering that particular section.
   b. The notes from which the material was taken.
   c. The bibliography cards used in making the footnotes.

4. Compare an article from a popular magazine digest with its original.
5. Submit ten note cards which contain both quoted and abstracted material. Explain why some of the material was quoted, some abstracted.
6. Compile a list bibliography of ten to twelve titles, and add a note to each one, justifying your selection by evaluating the source.
7. Make a glossary and a short index for your report.
8. Make a list bibliography in three separate forms:

   a. Follow the form used in this chapter.
   b. Follow the form used in a technical journal of your profession.
   c. Follow the form used in one of your textbooks.

9. Write an abstract of your report.
10. Examine carefully three books from your bibliography. Then in less than 150 words explain why one of the three is probably better for your purposes than the other two.
11. Write an introduction for your research report.
12. Write a conclusion for your research report.

Chapter Fourteen

Make-up for the Long Paper

IMPORTANCE OF IMMEDIATE IMPRESSION

The make-up, or layout, of the long paper is important for the reader's first impression. If the paper is poorly thrown together, with soiled finger marks in the margins, with a lack of uniformity of pagination, and with the appearance of a dogeared document, the general conclusion is that the paper itself is miserably composed, poorly punctuated, and badly organized. This, of course, is not always true; but a neatly written and well-assembled paper will always incite immediate interest on the part of the reader and stimulate him to look further into the document.

COVER

First of all, a suitable cover should be purchased at a paper supply shop. It should be of the heavier and more durable variety, probably halfway in strength between Manila paper and cardboard. There should be no printing on the outside. As a rule, it should measure 9 by 11½ inches, amply covering the 8½- by 11-inch paper on which the report is written. Often, it is possible to buy a cover with a small oblong indentation, about 4½ by 1½ inches, that runs lengthwise across the upper middle half of it; often, too, a small piece of oblong paper, fitting exactly into this indentation, comes with the cover. On one side, this small paper is gummed so that it can be stuck securely onto the cover, and upon it the title of the report and the name of the author are lettered in ink or are typed. The student would do well to choose a cover of a neutral shade—dark blue or black or tan—and he should have three metal staples to hold securely the papers of the report between the front and back pages of his cover.

TITLE PAGE

Another important feature in the make-up of the long paper is the design of the title page. Here, in lettering of a conservative nature,

the reader expects to find (1) the complete title of the report, (2) the name of the author, and (3) the college course and number for which the paper is written. The design of the page, as suggested, should be modest. The lettering should be done with black drawing ink and properly spaced on the 8½- by 11-inch paper. The title should be placed in the middle of the upper half of the paper, with equal margins to the right and to the left of it. The author's name should be placed under the title, also accurately centered on the page. If desired, the word "by" can be used, under the title, of course, and above the name of the author, as here indicated.

The Process of Type Design
by
Howard A. Douglass

The lower half of the title page should contain the name of the course for which the paper is written and the date on which it is due; this information should also be proportioned in the center of the page and should be lettered so that it is not more than 2½ or 3 inches from the bottom of the paper, as here indicated.

English 411
Winter Quarter 1937

TABLE OF CONTENTS

In the make-up of the long paper, the page that follows the title page is the one which contains the table of contents. The items in the table of contents, of course, are the main divisions of the outline around which the long paper was written. They are the pegs, so to speak, on which the information contained in the paper has been organized. These items should be labeled "Contents" or "Table of Contents," and should be spaced on the page so that the margin at the right of the sheet will equal the margin at the left, and the margin at the top will equal the margin at the bottom. If the student is typing his paper, it is better to use double spacing. When placed on the page, allowing, of course, for equal margins right and left and equal margins top and bottom, the table should look like the one shown at the top of page 226.

The list of figures and tables and the letter of transmittal may also be included in the table of contents. The pagination for this prefatory material is in Roman numerals.

Contents

When the paper is put in its final form, it is better to write or type this page after the report itself has been written. Not until then will the student know on just which pages will come the various items he is listing in his table of contents. After waiting until the report itself is in its final form, he will find it an easy matter to list the subtitles with the proper pagination after each one.

The list of figures and tables comes next. If it is short, it may be added to the table of contents, or the items may be entered with the table of contents. Remember that figures, or graphs, diagrams, and photographs, are listed with Arabic numerals, as Fig. 1, Fig. 2, etc., but tables are listed with Roman numerals, as Table I, Table II, etc.

LETTER OF TRANSMITTAL

In the organization of the report, the letter of transmittal comes next. The student should be careful to see that the letter is properly spaced on the page. If he is typing his paper, most naturally the letter of transmittal also will be typed. Even if he used double spacing in the body of his report, in the letter of transmittal he should use single spacing, with double spacing between paragraphs. At the end of the letter, his signature should be written in black or blue-black ink. He should never use colored ink.

FIRST PAGE

The first page of the report itself then follows. In writing his first page, the student should never begin at the very top of his 8½- by 11-inch paper. The writing should begin a short way above the middle of the page, probably about 4 inches from the top of the paper. Also, halfway between the first line of the report and the top of the paper, he should write the complete title of the report, properly spaced with equal margins to the right and left of it. In other words, he should place the title about 2 inches from the top of the paper, provided he starts the first line of his report 4 inches from the

top. The margin at the right of the paper should be about 1½ inches; at the bottom of the paper, about 1¼ inches; and at the left of the paper about 2 inches, thus allowing for the "slack" that is taken up by the binding when the metal staples are placed through the edges of the cover. There is still one more item to consider on the first page of the report itself: the Arabic number one (1) is placed in the margin at the bottom of the page, squarely in the middle, leaving equal space to the right and to the left of it.

LATER PAGES

On the second and succeeding pages of the report itself, the writing should start at the top of the page, leaving, not the 4-inch margin as on the first page, but 1¼-inch margin. This will mean that margins on the second and succeeding pages will register 1¼ inches at the top of the paper, 1½ inch at the right of the paper, 1¼ inches at the bottom of the paper and 3 inches at the left of the paper. The pagination on the second and succeeding pages is different from that on the first page. For example, on page 2 the Arabic number two (2) is placed in the upper right-hand corner of the paper, on a line with the beginning of the right-hand margin and about ¼ inch from the top of the paper.

ILLUSTRATIONS

Since illustrations are always helpful to a reader in describing the text of a report, the student should use them when necessary and advisable. Small illustrations used on a page of the report should be so placed that they illustrate the text on the page where they are fixed. For example, it is not wise to explain a simple process on page two and have the illustrations of the process attached on either page three or page four. The illustration should always have a title under it, either typed or lettered in black drawing ink. If an illustration has been clipped from a magazine or from other source material, it should have the name of the source placed immediately under it at the right. Care should be exercised, also, to see that the text of the report does not encroach upon the narrow margin maintained about the illustration. That margin should be at least ¼ inch in width. Care also should be taken to see that no illustration is placed on a page so that any portion of the illustration extends into the margin at the side, bottom, or top of the page.

In the use of illustrative material, the student may find it advisable to use charts, drawings, flow sheets, etc., that cover the entire $8\frac{1}{2}$- by 11-inch page (with the exception, of course, of the required margins). If the student himself has made these drawings, he should place his initials in the lower right-hand corner of the plate and under them the date when he finished the work on it. Like the illustration, the drawing should have a title placed in the middle of the plate at the bottom.

ASSEMBLY

After all these directions are followed, the student is ready at last to put his pages in order and fasten them between the pages of the cover. In doing this, he will need two blank pages of paper, the same size, color, and quality as those on which he has written his report. All the pages are then assembled and fastened in the binder cover so that, when the reader picks up the finished product, he will find the pages in the following order: (1) the cover containing the title of the report and the name of the author; (2) a blank page; (3) the title page containing the title of the report; (4) the table of contents; (5) the letter of transmittal; (6) the first page of the report itself; (7) pages 2, 3, 4, etc., to the end of the report; (8) a blank page; and (9) the blank back page of the cover. The research report will include appendix matter, at least the list bibliography, with the paging by Arabic numerals continued.

It takes time, plenty of time, to prepare and assemble a paper of this type; but after the job is completed and the author sits down to look over his finished project, he will discover that his efforts have been adequately rewarded.

A FEW DO AND DON'T GUIDES IN MAKE-UP

Never buy a gaudy-colored cover.

Be sure the staples are the type that will hold the pages securely.

Do not put the word "by" on the cover. Use only the title of the theme and the name of the author.

Buy good quality paper. Avoid the use of extremely thin bond paper; it will wrinkle badly if any illustrative material is pasted on it.

If the paper is typed, use double spacing for the theme proper and single spacing for the letter of transmittal.

If the paper is written in longhand, buy lined paper with lines $\frac{3}{8}$ inch apart. Do not use unruled paper unless your writing follows a straight line.

Place titles on all drawings, charts, flow sheets, illustrative material, etc. If the material is clipped from other sources, make acknowledgment by placing the name of the periodical under the clipping, in the lower right-hand corner. Always see that margins are maintained around the four sides of the illustration.

Be sure that all pages, including full-page illustrative material, are numbered.

Be sure that the subtitles interspersed throughout the text are put in "caps" (if typed) or underscored (if written in longhand).

Appendixes

Appendix A

Suggested Reading Lists for Students

No reading list can be final, in the true sense of the word. As the world changes so does its literature as well as the literary tastes of its people. The three or four most widely read novels of ten years ago are amazingly absent from the minds of the readers today. In a measure, probably, these recessions of literary fashion are due to the very fact that publishers are publishing almost any manuscript that is sent to them, and that for the last twenty years printing presses have been working overtime. The result is a mixed concoction of what is good and what is poor.

Therefore, it is easy to understand the clouded literary horizon that confronts college students who wish to do profitable reading in their leisure moments. Actually, they do not know where to begin. During their high school years they have been exposed to Sir Walter Scott and George Eliot, to Dickens and Shakespeare. Probably they have read some of the poetry of Keats, Wordsworth, Byron, and Shelley, and, no doubt, they know a little about Walt Whitman. During college years, without guidance, these same students may let their reading slip entirely, or they may direct their attentions to books that lack the proper mental stimulation to nurture the reading instinct already formed.

Several basic principles underlie the selections in a reading list. In the first place, any such list should contain titles of books that are at least a few years old, as well as those that are new. Secondly, the books should present human and enjoyable aspects of reading. The third basic principle to govern one's reading rests upon personal interest; although books that are interesting to one person will not have equal value or meaning for his neighbor, there are some which make a wide, almost universal, appeal.

The following reading lists, therefore, are designed to aid college students, especially those in technical schools, in the selection of reading materials of value, in the selection of books that are old as well as new, books that are human and enjoyable, and books that are interesting along various lines of contemporary thought. Undoubtedly, the lists will be helpful to college graduates also, for no student, with the amount of classwork that he takes

during his college career, can be expected to read every item included in them, within college years.

While these reading lists are far from final, they are offered with the idea of opening the way to moments of pleasure in the company of some of the most enjoyable and human books written during the last forty years.

A FEW BOOKS THAT LINK SCIENCE TO LITERATURE

Astronomy

EDDINGTON, ARTHUR S., *Borderland of Astronomy and Geology; Stars and Atoms.*
HALE, GEORGE E., *Beyond the Milky Way.*
JEANS, JAMES H., *The Stars in Their Courses; The New Background of Science.*
MCKREADY, KELVIN, *A Beginner's Star-book.*

Chemistry and Physics

BRAGG, WILLIAM H., *Concerning the Nature of Things.*
JAFFE, BERNARD, *Crucibles.*
MILLIKAN, ROBERT A., *Time, Matter and Values.*
PLANCK, MAX, *Where Is Science Going?*
SLOSSON, E. E., *Creative Chemistry.*
TILDEN, WILLIAM, *Famous Chemists.*

Geology

LEE, WILLIS T., *Stories in Stones.*
LUCAS, F. A., *Animals of the Past.*
PLATT, WILLIAM, *The Joy of the Mountains; A Popular Geology*

Medical Sciences

BEERS, CLIFFORD, *A Mind That Found Itself.*
DUCLAUX, EMILE, *Pasteur, the History of a Mind.*
FINNEY, J. M. T., *The Physician.*
KRUIF, PAUL DE, *Microbe Hunters; Men Against Death; Why Keep Them Alive? The Fight for Life.*
MORRIS, ROBERT T., *Doctors versus Folks.*
VALLERY-RADOT, *The Life of Pasteur.*
WYETH, JOHN A., *With Sabre and Scalpel.*

Nature Study

BEEBE, C. WILLIAM, *Beneath Tropic Seas; Jungle Peace; Galapagos, World's End.*
BURROUGHS, JOHN, *A Year in the Fields; Under the Maples; Ways of Nature.*
THOMSON, J. ARTHUR, *Every-day Biology; The Control of Life; Science, Old and New.*

THE MODERN SHORT STORY

Anthologies

BATES, S. C., *Twentieth Century Stories*, 1933.
BERDAN, JOHN M., *Fourteen Stories from One Plot*, 1932.
BROWN, LEONARD, *Modern American and British Short Stories*, 1937.
CROSS, E. A., *A Book of the Short Story*, 1934.
FERGUSON, DEL., W. R. DUMBLE, and H. A. BLAINE, *Theme and Variation in the Short Story*, 1938.
FREDERICK, J. T., *Stories from The Midland*, 1924.
HASTINGS, W. T., B. C. CLOUGH, and K. O. MASON, *Short Stories*, 1924.
HIBBARD, ADDISON, *Stories of the South*, 1931.
KNICKERBOCKER, EDWIN VAN B., *Notable Short Stories of Today*, 1929.
LONG, RAY, *Twenty Best Stories*, 1933.
O'BRIEN, E. J., *The Twenty-five Finest Short Stories*, 1931.
OVERTON, GRANT, *Great Modern Short Stories*, 1903.
PENCE, RAYMOND W., *Short Stories of Today*, 1934.
PUGH, CYNTHIA A., *A Book of Short Stories*, 1931.
RAMSAY, ROBERT L., *Short Stories of America*, 1921.
SCARBOROUGH, DOROTHY, *Selected Short Stories of Today*, 1935.

Individual Authors

ANDERSON, SHERWOOD, *Winesburg, Ohio.*
BURKE, THOMAS, *Limehouse Nights.*
CANFIELD, DOROTHY, *Hillsboro People; The Real Motive; Made-to-Order Stories.*
CATHER, WILLA S., *Youth and the Bright Medusa; Obscure Destinies.*
CHEKHOV, ANTON, *Collected Stories.*
FERBER, EDNA, *Buttered Side Down; Cheerful, by Request; Mother Knows Best.*
FITZGERALD, F. SCOTT, *All the Sad Young Men.*
GALSWORTHY, JOHN, *Caravan.*
HARTE, BRET, *The Luck of Roaring Camp.*
HEMINGWAY, ERNEST, *Men Without Women; Winner Take Nothing.*
HENRY, O., *Selected Stories*, 1922.
HUXLEY, ALDOUS, *Brief Candles.*
KIPLING, RUDYARD, *Plain Tales from the Hills.*
LARDNER, RING, *Round-Up.*
MANN, THOMAS, *Death in Venice.*
MANSFIELD, KATHERINE, *The Garden Party.*
MAUGHAM, W. SOMERSET, *East and West; Ah King; The Trembling of a Leaf.*
MAUPASSANT, GUY DE, *Short Stories.*
MORRISON, ARTHUR, *Tales of Mean Streets.*
PARKER, DOROTHY, *After Such Pleasures.*
POE, EDGAR ALLAN, *Tales.*
SAKI, *Short Stories*, 1930.
SUCKOW, RUTH, *Iowa Interiors.*

MODERN AMERICAN AND ENGLISH FICTION

ALLEN, HERVEY, *Anthony Adverse.*

BENNETT, E. ARNOLD, *The Old Wives' Tale; Imperial Palace.*

BOYD, JAMES, *Drums; Marching On; Long Hunt.*

BROMFIELD, LOUIS, *The Farm; A Good Woman; The Green Bay Tree; Possession; Early Autumn; Twenty-four Hours.*

BUCK, PEARL, *The Good Earth; Sons; A House Divided.*

CANFIELD, DOROTHY, *The Bent Twig; The Deepening Stream; Her Son's Wife.*

CARROLL, GLADYS H., *As the Earth Turns.*

CATHER, WILLA S., *My Antonia; O Pioneers; A Lost Lady; Death Comes for the Archbishop; Song of the Lark; Shadows on the Rock; The Professor's House; Lucy Gayheart.*

COBB, HUMPHREY, *Paths of Glory.*

CONRAD, JOSEPH, *Youth; Lord Jim; Victory; The Arrow of Gold.*

DE LA ROCHE, MAZO, *Jalna; Whiteoaks of Jalna; Portrait of a Dog.*

DOS PASSOS, JOHN, *Three Soldiers; Manhattan Transfer.*

DREISER, THEODORE, *An American Tragedy; Sister Carrie; Jennie Gerhardt.*

FAULKNER, WILLIAM, *As I Lay Dying; Sanctuary.*

FERBER, EDNA, *Cimarron; So Big; Come and Get It; Show Boat; American Beauty.*

GALSWORTHY, JOHN, *The Forsyte Saga; The Modern Comedy.*

GLASGOW, ELLEN, *Barren Ground; They Stoop to Folly; The Vein of Iron; The Romantic Comedians.*

HEMINGWAY, ERNEST, *A Farewell to Arms; The Sun Also Rises; Death in the Afternoon.*

HERGESHEIMER, JOSEPH, *Java Head; The Three Black Pennys; Cytherea; The Bright Shawl.*

HEYWARD, DU BOSE, *Porgy; Angel; Mamba's Daughters.*

HILTON, JAMES, *Goodbye, Mr. Chipps; Lost Horizon.*

HUXLEY, ALDOUS, *Point Counter Point; Brave New World.*

LAWRENCE, D. H., *Sons and Lovers.*

LEWIS, SINCLAIR, *Arrowsmith; Babbitt; Main Street; Dodsworth.*

LOCKE, WILLIAM J., *The Beloved Vagabond.*

MAUGHAM, W. SOMERSET, *Of Human Bondage; The Moon and Sixpence; Cakes and Ale; Theatre.*

MORGAN, CHARLES, *The Fountain; Sparkenbroke.*

MORLEY, CHRISTOPHER, *Parnassus on Wheels; Thunder on the Left; John Mistletoe.*

PRIESTLEY, JOHN B., *The Good Companions.*

ROLVAAG, O. E., *Giants in the Earth.*

SABATINI, RAFAEL, *The Sea Hawk; Scaramouche.*

SANTAYANA, GEORGE, *The Last Puritan.*

STONG, PHIL, *State Fair; Stranger's Return.*

SUCKOW, RUTH, *The Folks; Country People; The Kramer Girls.*

TARKINGTON, BOOTH, *Alice Adams; The Magnificant Ambersons; Seventeen; Gentle Julia; The Turmoil.*

WALPOLE, HUGH, *The Cathedral; Fortitude; Jeremy.*

WELLS, H. G., *Tono-Bungay; The War in the Air; The Time Machine; Mr. Britling Sees It Through.*
WHARTON, EDITH, *Ethan Frome; The Age of Innocence; The Children.*
WILDER, THORNTON, *The Bridge of San Luis Rey.*
WOLFE, THOMAS, *Look Homeward, Angel; Of Time and the River.*
WOOLF, VIRGINIA, *Flush; Mrs. Dalloway; The Waves; The Years.*

MODERN CONTINENTAL FICTION

BAUM, VICKI, *Grand Hotel.*
BLASCO-IBANEZ, VICENTE, *The Four Horsemen of the Apocalypse.*
HAMSUN, KNUT, *Growth of the Soil; Hunger.*
MANN, THOMAS, *Buddenbrooks; The Magic Mountain.*
REMARQUE, ERICH M., *All Quiet on the Western Front; The Road Back.*
WERFEL, FRANZ, *The Forty Days of Musa Dagh.*
ZWEIG, ARNOLD, *The Case of Sergeant Grischa; Education before Verdun.*

BIOGRAPHY AND AUTOBIOGRAPHY

ADAMS, HENRY, *The Education of Henry Adams.*
ADDAMS, JANE, *Twenty Years at Hull House.*
ALLEN, HERVEY, *Israfel: The Life and Times of Edgar Allan Poe.*
ARLISS, GEORGE, *Up the Years from Bloomsbury.*
BOK, EDWARD W. *The Americanization of Edward Bok.*
BOYD, THOMAS, *Poor John Fitch.*
BRADFORD, GAMALIEL, *Damaged Souls.*
BRYAN, GEORGE S., *Edison, The Man and His Work.*
CELLINI, BENVENUTO, *Autobiography.*
CRAVEN, THOMAS, *Men of Art.*
DURANTY, WALTER, *I Write as I Please.*
GARLAND, HAMLIN, *A Son of the Middle Border.*
HACKETT, FRANCIS, *Henry the Eighth; Francis the First.*
HUNT, FRAZIER, *A Bachelor Prince.*
JAMES, MARQUIS, *The Raven.*
KRUIF, PAUL DE, *Microbe Hunters; Hunger Fighters; Men Against Death.*
LAMSON, DAVID, *We Who Are About to Die.*
LAWRENCE, T. E., *Seven Pillars of Wisdom.*
LUDWIG, EMIL, *Bismarck; Napoleon.*
MASTERS, EDGAR LEE, *Lincoln the Man.*
MAUROIS, ANDRÉ, *Ariel: The Life of Shelley; Byron; Disraeli.*
MEREJKOWSKI, DMITRI, *The Romance of Leonardo da Vinci.*
MUMFORD, LEWIS, *Herman Melville.*
PEATTIE, DONALD CULROSS, *Green Laurels.*
PRINGLE, HENRY F., *Theodore Roosevelt.*
SANDBURG, CARL, *Abraham Lincoln.*
SANDOZ, MARI, *Old Jules.*
SELDES, GEORGE, *Sawdust Caesar.*
SHEEAN, VINCENT, *Personal History.*

STEFFENS, LINCOLN, *Autobiography.*
STRACHEY, LYTTON, *Eminent Victorians; Queen Victoria; Elizabeth and Essex.*
TWAIN, MARK, *Mark Twain's Notebook.*
WALKER, STANLEY, *City Editor.*
WELLS, H. G., *Experiment in Autobiography.*
WERNER, M. L., *Barnum.*
WHARTON, EDITH, *A Backward Glance.*
YEATS-BROWN, FRANCIS, *Lives of a Bengal Lancer.*
ZWEIG, STEFAN, *Marie Antoinette; Mary, Queen of Scotland.*

FAMILIAR ESSAY

BELLOC, HILAIRE, *Conversation with a Cat, and Other Essays.*
BENCHLEY, ROBERT, *Early Worm; From Bed to Worse; Treasurer's Report.*
BENSON, A. C., *Rambles and Reflections.*
BOYD, ERNEST, *Literary Blasphemies.*
BROWN, ROLLO W., *Lonely Americans.*
BUTLER, NICHOLAS M., *Between Two Worlds.*
CANBY, HENRY S., *American Estimates.*
CHASE, MARY ELLEN, *Golden Asses and Other Essays.*
CHESTERTON, GILBERT K., *Generally Speaking; Poet and The Lunatics.*
DAY, CLARENCE, *Life with Father.*
FIRKINS, OSCAR W., *Selected Essays.*
GALSWORTHY, JOHN, *Candelabra.*
GUEDALLA, PHILIP, *Bonnet and Shawl; Supers and Supermen.*
HERGESHEIMER, JOSEPH, *Swords and Roses.*
HUXLEY, ALDOUS, *Music at Night, and Other Essays.*
KNOX, RONALD A., *Caliban in Grub Street.*
LEACOCK, STEPHEN, *Wet Wit and Dry Humor; Iron Man and Tin Woman; Afternoons in Utopia.*
LUCAS, E. V., *Lemon and Verbena, and Other Essays.*
MCFEE, WILLIAM, *Swallowing the Anchor.*
MASSON, THOMAS, *Our American Humorists.*
MENCKEN, H. L., *Selected Prejudices.*
MILLIKAN, ROBERT A., *Evolution in Science and Religion; Science and the New Civilization.*
MILNE, A. A., *By Way of Introduction.*
MORLEY, CHRISTOPHER, *Romany Stain.*
PHELPS, WILLIAM LYON, *As I Like It; Essays on Things.*
PRIESTLEY, J. B., *I for One; Open House.*
REPPLIER, AGNES, *Times and Tendencies.*
SEITZ, DON, *The "Also Rans."*
STRUNSKY, SIMEON, *Rediscovery of Jones.*
VAN VECHTEN, CARL, *Excavations; Sacred and Profane-Memories.*
WILSON, EDMUND, *American Jitters.*
WOOLCOTT, ALEXANDER, *Enchanted Aisles; While Rome Burns.*
YOUNG, STARK, *Glamour; Essays on the Art of the Theatre.*

MODERN DRAMA

English and American

AKINS, ZOE, *The Old Maid; Déclassée.*

ANDERSON, MAXWELL, *Queen Elizabeth; Valley Forge; Saturday's Children; Mary of Scotland; Winterset; The Wingless Victory; High Tor.*

———, and LAURENCE STALLINGS, *What Price Glory?*

BARRIE, JAMES M., *Quality Street; Dear Brutus; What Every Woman Knows; The Admirable Crichton.*

BARRY, PHILIP, *Animal Kingdom; Paris Bound.*

BENNETT, E. ARNOLD, *Milestones.*

BESIER, RUDOLPH, *The Barrets of Wimpole Street.*

BRIGHOUSE, HAROLD, *Hobson's Choice.*

CONNELLY, MARC, *The Green Pastures; The Wisdom Tooth.*

COWARD, NOEL, *Cavalcade; Design for Living; Private Lives.*

CROTHERS, RACHEL, *Nice People; Mary the Third; As Husbands Go; He and She; Let Us Be Gay; Susan and God.*

DAVIS, OWEN, *Icebound.*

DRINKWATER, JOHN, *Abraham Lincoln; Marie Stuart; Robert E. Lee.*

FITCH, CLYDE, *The Climbers; The Truth; The Girl with the Green Eyes.*

FRANKEN, ROSE, *Another Language.*

FLAVIN, MARTIN, *Children of the Moon; Criminal Code.*

GALE, ZONA, *Miss Lulu Bett.*

GALSWORTHY, JOHN, *Strife; Justice; Escape; The Silver Box; Loyalties.*

GREEN, PAUL, *The House of Connelly; In Abraham's Bosom.*

HEYWOOD, DUBOSE, *Brass Ankle.*

HOWARD, SIDNEY, *Ned McCobb's Daughter; The Silver Cord; They Knew What They Wanted; Yellow Jack.*

JONES, HENRY A., *Mrs. Dane's Defense.*

KAUFMAN, GEORGE, *Merton of the Movies* (with Marc Connelly); *To the Ladies* (with Marc Connelly); *Beggar on Horseback* (with Edna Ferber); *The Royal Family* (with Edna Ferber); *Dinner at Eight* (with Edna Ferber); *Of Thee I Sing* (with Morrie Ryskind).

KELLY, GEORGE, *The Torch Bearers; Craig's Wife; Daisy Mayme; The Show-off.*

KINGSLEY, SIDNEY, *Men in White; Dead End.*

MAUGHAM, W. S., *Rain; The Circle; The Letter; Our Betters; The Constant Wife.*

MILNE, A. A., *The Dover Road; Mr. Pim Passes By; The Ivory Door; The Truth About Blayds.*

MOODY, WILLIAM V., *The Great Divide.*

O'NEILL, EUGENE, *Strange Interlude; Mourning Becomes Electra; Days Without End; Anna Christie; The Hairy Ape; Dynamo; Beyond the Horizon; Ah Wilderness!; The Emperor Jones; Mareo Millions; The Straw.*

PINERO, ARTHUR W., *Mid-Channel; The Second Mrs. Tanqueray; Trelawney of the Wells.*

RICE, ELMER, *The Adding Machine; Street Scene.*

SHAW, GEORGE B., *Man and Superman; The Doctor's Dilemma; Pygmalion; Arms and the Man; Candida.*

SHERIFF, R. C., *Journey's End.*

SYNGE, JOHN M., *The Playboy of the Western World; Riders to the Sea.*

THOMAS, AUGUSTUS, *The Copperhead.*

WALTER, EUGENE, *The Easiest Way.*

WILDE, OSCAR, *Lady Windermere's Fan; The Importance of Being Earnest.*

Continental

ANDREYEV, LEONID, *He Who Gets Slapped.*

CAPEK, KAREL, *R.U.R.*

CHEKHOV, ANTON, *The Cherry Orchard; The Sea Gull; Uncle Vanya; Three Sisters.*

HAUPTMAN, GERHART, *The Sunken Bell; The Rats; The Weavers.*

IBSEN, HENRIK: *A Doll's House; Rosmersholm; Ghosts; Hedda Gabler; The Wild Duck; An Enemy of the People.*

MAETERLINCK, MAURICE, *Pelleas and Melisande.*

MOLNAR, FERENC, *Liliom; The Swan; The Guardsman.*

PIRANDELLO, LUIGI, *Right You Are!; Six Characters in Search of an Author.*

ROSTAND, EDMOND, *L'Aiglon; Cyrano de Bergerac; The Romancers.*

SCHNITZLER, ARTHUR, *Anatol; Light o'Love.*

STRINDBERG, AUGUST, *The Father; The Dance of Death; There Are Crimes and Crimes.*

SUDERMANN, HERMAN, *John the Baptist; Magda.*

English, American, and Continental One-act Plays

BARRIE, JAMES M., *Half an Hour; Seven Women; Old Friends; Rosaline; The Will; The Twelve-pound Look; The New World; A Well-remembered Voice; Barbara's Wedding; The Old Lady Shows Her Medals; Shall We Join the Ladies?*

BROUN, HEYWOOD C., *Death Says It Isn't So.*

CHEKHOV, ANTON, *The Marriage Proposal.*

COWAN, SADA, *In the Morgue.*

CROTHERS, RACHEL, *Peggy.*

DRINKWATER, JOHN, *X Equals Zero.*

FERBER, EDNA, *The Eldest.*

FLAVIN, MARTIN, *Brains; Caleb Stone's Death Watch.*

GALSWORTHY, JOHN, *The First and the Last; Punch and Go.*

GLASPELL, SUSAN, *Trifles; Close the Book.*

GREEN, PAUL, *The Last of the Loweries; The Man Who Died at Twelve O'Clock; The No' Count Boy.*

JACOBS, WILLIAM W., *The Monkey's Paw.*

MASEFIELD, JOHN, *Good Friday; The Locked Chest.*

MILNE, A. A., *The Man in the Bowler Hat; The Boy Comes Home.*

NUGENT, ELLIOTT and HOWARD LINDSAY, *Apartment to Let.*

O'NEILL, EUGENE, *Before Breakfast; The Dreamy Kid; In the Zone; The Long Voyage Home; Ile; Where the Cross is Made.*

SCHNITZLER, ARTHUR, *The Farewell Supper.*
SHAW, IRWIN, *Bury the Dead.*
SHAW, G. B., *Augustus Did His Bit; How He Lied to Her Husband.*
TARKINGTON, BOOTH, *The Ghost Story; Bimbo, The Pirate.*
WILDE, OSCAR, *A Florentine Tragedy; Birthday of the Infanta.*
WILDE, PERCIVAL, *The Noble Lord; The Finger of God.*

MODERN POETRY

BENET, STEPHEN V., *John Brown's Body.*
BRIDGES, ROBERT, *Testament of Beauty.*
BROOKE, RUPERT, *Collected Poems*, 1918.
ELIOT, T. S., *Poems*, 1927.
ENGLE, PAUL, *American Song*, 1934.
FROST, ROBERT, *Selected Poems*, 1928.
JEFFERS, ROBINSON, *The Roan Stallion and Other Poems.*
KIPLING, RUDYARD, *Collected Verse*, 1919.
LIEBERMAN, ELIAS, *Poems for Enjoyment*, 1931.
LINDSAY, VACHEL, *Selected Poems*, 1925.
LOWELL, AMY, *Selected Poems*, 1928.
MACLEISH, ARCHIBALD, *Poems, 1924-1933*, 1933.
MASEFIELD, JOHN, *Selected Poems.*
MASTERS, EDGAR LEE, *Spoon River Anthology*, 1915.
MILLAY, EDNA ST. V., *The Buck in the Snow; Fatal Interview; The King's Henchman.*
NOYES, ALFRED, *Forty Singing Seamen and Other Poems.*
PARKER, DOROTHY, *Death and Taxes; Sunset Gun.*
Prize Poems, 1913–1929, Ed. by Charles A. Wagner.
ROBINSON, EDWIN A., *Collected Poems*, 1921.
SANDBURG, CARL, *Selected Poems*, 1926.

Appendix B

References on Writing for Students

(Note: Includes works of interest to both students and teachers. The References for Teachers contain more advanced studies.)

Agg, T. R., and W. I. Foster, *The Preparation of Engineering Reports*, McGraw-Hill Book Company, Inc., New York, 1935; viii + 192 pp., illus., diagrs.

Gives concrete directions for handling graphic elements and for the form of reports.

The American Society of Mechanical Engineers: *Style Manual for Engineering Authors and Editors*, New York, 1927; 26 pp.

Illustrates standard practice of a leading professional society.

Baldwin, H. M., H. L. Creek, and J. H. McKee, *A Handbook of Modern Writing*, The Macmillan Company, New York, 1930; xix + 378 pp., 215 rules, illus.

Adapted to needs of scientific students.

Brinton, W. C., *Graphic Methods for Presenting Facts*, Engineering Magazine Company, 1914; xii + 371 pp., illus., diagrs.

A standard work on graphs.

Century Dictionary and Cyclopedia, D. Appleton-Century Company, New York, 1909, revised and enlarged edition; 12 vols., illus., plates, maps, charts. Abridged, 1927; 2 vols.

Reliable for older scientific words.

Clark, Thomas Arkle, *When You Write a Letter*, Benjamin H. Sanborn & Company, Chicago, 1922; 165 pp.

An unusually readable book which contains most of the practical information needed.

Cole, Arthur H. and Karl W. Bigelow, *A Manual of Thesis Writing*, John Wiley & Sons, Inc., New York, 1934; ix + 48 pp., illus.

For both graduate and undergraduate students.

Curme, George O., *College English Grammar*, Johnson Publishing Company, Richmond, Va., 1925; xxii + 414 pp.

A reliable short grammar, based on years of research and collection of examples from written and spoken use of English.

Desk Standard Dictionary, Funk & Wagnalls Company, New York, 1924; viii + 894 pp., illus.

A new edition by Frank H. Vizetelly.

Encyclopaedia Britannica, Encyclopaedia Britannica, Inc., New York, 14th ed., 1927; 24 vols., illus., plates, ports., maps, diagrs.

FERNALD, JAMES C., *English Synonyms and Antonyms with Notes on the Correct Use of Prepositions*, Funk & Wagnalls Company, New York, 1896, rev. 1914; x + 564 pp.

Deals with common words and their idiomatic use in a context.

FOERSTER, NORMAN, and J. M. STEADMAN, *Writing and Thinking, A Handbook of Composition and Revision*, Houghton Mifflin Company, Boston, 1931; vi + 449 pp., illus.

A widely used handbook for general problems of writing, with logical qualities accented.

FRENCH, THOMAS E., *A Manual of Engineering Drawing*, McGraw-Hill Book Company, Inc., New York, 1935; xv + 481 pp., illus., diagrs.

This standard work contains a chapter on graphs, and references to special books.

FULCHER, GORDON S., "Scientific Abstracting," *Reprint and Circular Series*, National Research Council, Washington, D. C. 1921. (Originally in *Science*, Sept. 30, 1921 Vol. LIV, No. 1396, pp. 291–5.)

Advocates "analytic abstracts" with significant headings.

GAUM, C. G., and H. F. GRAVES, *Report Writing*, Prentice-Hall, Inc., New York, 1929; xi + 319 pp., illus., diagrs.

Valuable as a general survey. Has bibliography and special lists of compounds, etc.

HARBARGER, S. A., *English for Engineers*, McGraw-Hill Book Company, Inc., New York, 3d ed., 1934; xvi + 314 pp.

Chap. XXIII deals with The Engineering Report.

HASKELL, ALLAN C., *How to Make and Use Graphic Charts*, Codex Book Company, New York, 1919; iv + 539 pp., diagrs.

Standard for graphs and charts.

HUTCHINS, MARGARET, A. S. JOHNSON, and M. S. WILLIAMS, *Guide to the Use of Libraries*, H. W. Wilson Company, New York, 1929; 245 pp.

A handy book for library work. (Abridged ed. 1936; 86 pp., illus.)

HUTCHINSON, LOIS, *Standard Handbook for Secretaries*, McGraw-Hill Book Company, Inc., New York, 1936; x + 616 pp., illus. (map).

An unusually complete reference book on paper work and office practice.

KARSTEN, KARL G., *Charts and Graphs*, Prentice-Hall, Inc., New York, 1935; xi + 734 pp., illus., maps, diagrs.

A standard work.

KENNEDY, CLARENCE H., and BIRELY J. LANDIS, "On Writing Articles for the Entomological Society of America," *Annals of the Entomological Society of America*, 27: 357–372, September, 1934.

Shows how to use care and economy in technical articles.

A Manual of Style, University of Chicago Press, Chicago, 1935, 9th ed.; 401 pp., illus.

A work widely used for questions of form and type.

MCKNIGHT, GEORGE H., *English Words and Their Background*, D. Appleton-Century Company, New York, 1923; x + 449 pp.

Tells the story of various kinds of words, such as technical, dialectal, slang, etc.

ROGET, PETER MARK, *Roget's International Thesaurus of English Words and Phrases*, rev. and ed. by Christopher O. S. Mawson, The Thomas Crowell Company, New York, 1935; xxxvi + 799 pp.

Perhaps the best synonym dictionary. Analytical and topical in order, but provided with an index.

SANDFORD, W. P., and W. H. YEAGER, *The Principles of Effective Speaking*, Thomas Nelson & Sons, New York, 1934; xiv + 416 pp.

Valuable for analysis of elements of interest in a closely related field.

SEBOYAR, GERALD E., *Manual for Report and Thesis Writing*, F. S. Crofts and Company, Inc., New York, 1930; vi + 55 pp.

Useful for very elementary work.

STEVENSON, B. W., J. R. SPICER, and E. C. AMES, *English in Business and Engineering*, Prentice-Hall, Inc., New York, 1936; xvi + 365 pp., illus., map, diagrs.

An up-to-date, practical textbook.

New Standard Dictionary of the English Language, Funk & Wagnalls Company, New York, 1932, Editors: Isaac K. Funk, Calvin Thomas, Frank H. Vizetelly; xxxviii + 2814 pp., illus., plates, ports., maps.

Contains more than 455,000 words, many of them scientific terms.

SYPHERD, W. O., and SHARON BROWN, *The Engineer's Manual of English*, Scott, Foresman & Company, Chicago, 1933; xi + 515 pp., diagrs.

Chap. IV is "Report Writing"; pp. 194–199 contain "Research Reports."

TAFT, K. B., J. F. MCDERMOTT, and D. O. JENSEN, *The Technique of Composition*, Rev. ed. Farrar & Rinehart, Inc., New York, 1936; xv + 509 pp., diagrs.

Excellent in use of diagrams to illustrate grammatical relationships. A handbook and brief rhetoric combined.

THORNDIKE, E. L., *The Teacher's Word Book*, Teachers College, Columbia University, New York, 1927; vi + 134 pp. Revised, 1931.

A list of 10,000 high-frequency words from common reading sources.

THURBER, SAMUEL, ed., *Précis Writing for American Schools*, Little, Brown & Company, Boston, 1929; xi + 150 pp. Foreword by Charles S. Thomas.

Gives practical directions for summarizing.

U. S. Department of the Interior, *Suggestions to Authors of Papers Submitted for Publication by the U. S. Geological Survey*, U. S. Government Printing Office, Washington, D. C., 1935; 126 pp.

Gives directions for technical writing.

U. S. Government Printing Office, *Abridged Style Manual*, Washington, D. C., 1935; 168 pp., 20 cents.

A first-class reference work on matters of form.

U. S. Official Postal Guide, Government Printing Office, Washington, D. C.

Annual with monthly supplements, except for July. Useful for spelling and abbreviation of place names.

VAUGHAN, J. L., "Some Opinions of Engineers on the Importance of English," *Engineering Education*, 28: 482–495, March, 1938.

Statements from a representative group of more than fifty engineers answering the question: "Is English of any real importance to the practicing engineer?"

WARD, CHARLES H., *Grammar for Composition*, Scott, Foresman & Company, Chicago, 1933; xiii + 450 pp.

This book gives concrete methods of securing variety and effectiveness in style.

Webster's Collegiate Dictionary, G. & C. Merriam Company, Springfield, Mass., 1936; xl + 1222 pp., illus., diagrs.

Probably the most scholarly desk dictionary.

Webster's New International Dictionary of the English Language, 2nd ed., unabridged, G. and C. Merriam Company, Springfield, Mass., 1934; xcvi + 3210 pp., illus., plates, maps, ports., diagrs. Editors: W. A. Neilson, T. A. Knott, P. W. Carhart.

Contains more than 600,000 words, some of which are technical terms.

The Winston Simplified Dictionary, Advanced ed., John C. Winston Company, Philadelphia, 1928; 1260 pp., illus., maps, plates.

A usable book with excellent typography.

Wistar Institute Style Brief, Wistar Institute Press, Philadelphia, 1934; 164 pp., illus., plates.

Especially good for problems of scientific illustration.

Appendix C

Suggestions and References for Teachers

This book is written for student readers; hence it cannot go very far into the theory of rhetoric. The instructor who wishes to think through the underlying ideas, however, will find them in the books selected for the teacher's bibliography.

Some of the most ancient traditions of rhetoric are illustrated in scientific writing of today. Classical doctrines of the spoken word have come down to us modified to needs of the written word, mainly by such modern pioneers as Campbell, Whately, and Bain. These were the formulators of good use as national, present, and reputable; qualities of style as clearness, force, and elegance; and types of composition as description, exposition, etc. More recent masters like Wendell, Scott, and Denney have condensed Bain's paragraph laws into simple principles of unity, coherence, and emphasis, or their equivalents.

All these traditions, and many others, are still useful, though of late many of us have become a bit tired of the terminology. Even the classical *inventio*, *dispositio*, and *elocutio* can be adapted to modern teaching of investigation, organization, and effective statement. The story of rhetoric as it has developed into the real *organon* of the sciences is compactly told by Baldwin in Monroe's *Cyclopedia of Education.*

Rhetoric and poetic, no matter how unfortunately they may have been confused in the past (see Baldwin's medieval and Clark's Renaissance studies), stand well apart now. Teachers of creative writing justly object to mechanical rules. Teachers of factual writing, however, find their students much more hospitable to specifications, systems, and standards than to anything even remotely suggestive of dilettante attitudes. These hard-working apprentices in science will go along with us patiently, enthusiastically, and in the long run even imaginatively when we begin on common ground.

"That's all imagination!" said one of them when exposed at the wrong stage to Matthew Arnold's *Culture and Anarchy.* His younger brother, whose assignments have been better timed, can read *Cyrano de Bergerac* with

enjoyment and write about Boulder Dam (another great work of the imagination) with vividness.

Experience at many universities, including the Ohio State University (see the articles by Harbarger and Hildreth), has shown that genuine interest in both reading and writing can be developed by meeting the student halfway. Literature must be offered for recreation rather than study, in the leisure periods after and between writing assignments. In composition most students will respond heartily to such methods as:

1. Assigning letters and reports which are typical of professional practice.

2. Pointing out samples of clear, effective writing in textbooks and bulletins which are in everyday use.

3. Recognizing graphic forms and well-designed display as legitimate aids to scientific presentation.

4. Appreciating the practical values in concrete problems of applied science—an important source of interest to most readers.

Language teaching is a task in itself, apart from the larger aspects of composition. In spite of progressive methods in the schools, it still seems necessary for the average freshman, whether in Agriculture or Arts, to review if not to relearn the mother tongue.

What can we do about it? We can begin with technical language. Modern linguists like Bloomfield and modern logicians like Russell and Whitehead testify that mathematics *is* language, unsurpassed in exactness and universality. Equations and technical terms are highly standardized precision instruments. If we respect scientific statements because they are precise, then we may lead students to respect clear statements because they are practical.

We cannot be too dogmatic about points of usage which intelligent persons dispute (see Kennedy, Krapp, Leonard, McKnight, Pooley). We do not wish to exhume "make-believe grammar" from its well-earned resting place. Yet, it is true that responsible scientists write with care. Examples of standard English which is also interesting may be found in many textbooks and bulletins. These models mean more to the student than does grammatical analysis. When reputation is at stake (and is not reputation the main thing in usage?) the point does not need much elaboration.

Efficient correction is another meeting ground of instructor and student. With all its faults, a handbook of numbered rules is the most effective tool ever invented for the revision of mistakes in English. We must beware of a few fallacious rules which defy common sense and linguistic facts. Yet, most of the directions are sound, practical, and necessary. No student can learn to write by the numbers but many college freshmen have learned to correct and improve their language by the numbers, when they have used a good handbook.

Like so many labor-saving devices, the handbook has unfortunately added labor for the instructor, rather than reduced it. Teaching English composition is a hard job, from which many sensitive instructors have longed to escape into greener pastures.

The program of this book does not lead in that direction. We still look upon the teaching of English to the students who need it most as our own job. It must be an important one, for all freshmen have to come to us for their elementary work in English: language, composition, and literature. In short, the courses out of which this textbook has grown are merely adaptations of freshman English in its most practical form.

Yet, composition teaching is not all drudgery. In addition to a cultural background which begins with Aristotle, it opens new fields for research. Much criticism has been aimed at the Ph. D. degree insofar as it fits graduate students for special investigation and unfits them for teaching. A reaction against required work on problems which are remote from vital interest is taking place. A compromise is suggested by the growing interest in practical problems of teaching, as shown by numerous articles in *The English Journal*.

Not only in pedagogy, but also in the subject matter of rhetoric, there is much work to be done. The pioneer studies of Lewis on the paragraph, Sherman on the sentence, Leonard on usage, and Summey on punctuation could usefully be supplemented by more recent evidence. We need data on the proportion of simple words in effective style, the elements of interest, values of different arrangement, benefits of outlining, and many similar questions. Technical terms of the various crafts and sciences call for listing.

The general status of the field may be symbolized by the fact that there is no single complete history of rhetoric or of English rhetoric, in the English language.

Like the student in applied science, the graduate student in English who works in this field mainly by assignment may find problems in it which appeal to his imagination as well as his ambition.

RHETORIC

General and Historical

BAIN, ALEXANDER, *English Composition and Rhetoric*, American Book Company and D. Appleton-Century Company, Inc., New York, Original ed. 1866; enlarged, 2 vols., 1887–1888; xix + 310 pp.; xvi + 325 pp.

A pioneer in paragraph analysis and in division of types, such as description, exposition, etc.

BALDWIN, CHARLES S., "Rhetoric," *Cyclopedia of Education*, edited by Paul Monroe, The Macmillan Company, New York, 1914; vol. v, pp. 173–179.

A compact history down to modern times. See also Baldwin's *Ancient Rhetoric and Poetic;* xiv + 261 pp., 1924; and his *Medieval Rhetoric and Poetic*, xvii + 321 pp., 1928; The Macmillan Company, New York.

CAMPBELL, GEORGE, *The Philosophy of Rhetoric*, John Leavitt *et al.*, New York, original ed., 1776; new ed., 1834; 396 pp.

A great representative rhetoric of the eighteenth century. See Book II for the famous canons of usage.

CLARK, DONALD L., *Rhetoric and Poetry in the Renaissance*, Columbia University Press, New York, 1922; x + 166 pp.

Supplements Baldwin's history of the ancient and medieval periods. Shows especially how rhetoric and poetic became confused.

COOPER, LANE, ed., *Theories of Style, with Especial Reference to Prose Composition*, The Macmillan Company, New York, 1907, 1923; xxiii + 460 pp.

Valuable for selections from Spencer, Lewes, Stevenson, as well as older writers.

LEWIS, EDWIN H., *History of the English Paragraph*, University of Chicago Press, Chicago, 1894; 200 pp.

Gives data on paragraph length and structure during three centuries. Valuable for estimate of recent rhetoric.

SANDFORD, WILLIAM P., *English Theories of Public Address, 1530–1828*, H. L. Hedrick, Columbus, Ohio, 1929; 212 pp.

Though confined to public speaking, this history supplements Clark, from Cox to Whately.

SHERMAN, L. A., *Analytics of Literature. A Manual for the Objective Study of English Prose and Poetry*, Ginn and Company, Boston, 1893; 468 pp.

Studies sentences, much as Lewis studied paragraphs. Shows how the modern sentence has gained compactness.

WHATELY, RICHARD, *Elements of Rhetoric*, original ed., 1828; Harper and Brothers, New York, 1854; ix + 351 pp.

Another great, representative work, digesting classical tradition and introducing (in other terms) clearness, force, and elegance.

Note: *The Quarterly Journal of Speech* contains many valuable articles on older rhetoric.

Recent and Special

ALMACK, JOHN C., *Research and Thesis Writing*, Houghton Mifflin Company, Boston, 1930; xvii + 310 pp., diagrs.

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